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THE CENSUS OF THE GAS INDUSTRY.

It is desired to return thanks to the several hundred gas managers and officers of companies who have so promptly sent in their returns for this branch of the census, and especially for the completeness of the answers. In many instances it is doubtless difficult to give the information asked for regarding former years, from loss of records, want of proper care in keeping accounts in the earlier days of the industry, etc. In such cases, statements should be made from the best information to be had. The statistics for 1880, however, should be fully and accurately stated so that this, the first complete record of the magnitude and importance of the industry may be thoroughly reliable. To those who have not yet forwarded their returns, it is respectfully suggested that the matter receive as early attention as possible.

G. W. DRESSER,
Special Agent, etc.

THE ELEVENTH ANNUAL MEETING OF THE NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.

On the 16th, 17th and 18th of February last the Eleventh Annual Meeting of the New England Association was held in Boston. It was the largest in attendance of any meeting yet held, and the interest was kept up to the very last.

The President's address was one of those practical, straightforward and logical papers that rivets the attention of those who hear it, and can be read with great profit by all who are desirous of seeing the gas industry put upon an honest, progressive and paying basis. A singular fact becomes evident in reading the report of the proceedings, which is that the electric light was not once mentioned in the discussions.

This fact is not to be interpreted as indicating that no attention is being paid to the subject, but rather as showing the full confidence of the members in their ability to supply a reliable, agreeable and satisfactory light for less money than the electric light costs in its present state of development.

If the keynote of the President's address is to be accepted as any indication of the future intentions of the gas managers represented at the meeting it would appear that they by no means consider it necessary to maintain present prices of gas forever. Gas at one dollar per thousand was the problem presented; and most certainly a very clear outline of the necessary steps to be taken to accomplish such a result were fully set forth in the address.

One point was alluded to as a necessary preliminary and condition to enable the manager to supply his product at the price named, viz., "that capital should be so adjusted to business as not to exceed more than 50 cents per thousand on the yearly sales," which has a very important bearing on this problem. In fact, without a proper adjustment of capital to business, the gas maker is handicapped so heavily in the race that his best efforts may be paralyzed.

The standard of adjustment assumed is a fair one, inasmuch as five dollars capital for each thousand feet of annual sales ought to be enough to carry on the business successfully. That this is true is shown by the simple fact that there are dividend paying companies who have less capital than this; and where companies have more than this an item enters that cannot reasonably and properly be charged to the gas maker's account.

Any one of three things can be done, viz., reduce the capital, reduce the dividends, or increase the business.

The last course is very desirable, but cannot be accomplished in a day. Either of the two former steps may be taken at any time, if the stockholders or directors consent, and the road to the last course will thereby be made easy.

It is useless to ignore the fact that cheaper gas is not only to be in demand for supplying light, but also for use for heating, cooking and mechanical purposes; and those companies that put their houses in order for meeting this demand will be in a position to successfully cope with competition of every kind, whether it be kerosene oil or electricity.

The solution practically of the dollar problem is worthy of the ambition and zeal of any gas manager, and the sooner it is solved the surer will be the permanent, undisturbed and profitable establishment of the Gas Industry.

[A Lecture delivered Thursday, Jan. 27, at Glasgow, under the auspices of the Science Lectures Association.]

Gas and Electricity as Heating Agents.

By Dr. C. W. Siemens, F.R.S., Etc.

On the 24th of March, 1878, I had the honor of addressing you "On the Utilization of Heat and other Natural Forces." I then showed you the different forms of energy which Nature has provided for our uses had their origin, with the single exception of the tidal wave, in solar radiation; that the forces of wind and water, of heat and electricity, were attributable to this source; and that coal formed only a seeming and not a real exception to the rule—being the embodiment of a fractional portion of the solar energy of former geological ages.

On the present occasion I wish to confine myself to one branch only of the general subject—namely, the production of heat energy. I shall endeavor to prove that for all ordinary purposes of heating and melting, gaseous fuel should be resorted to; but that for the attainment of extreme degrees of heat the electric arc possesses advantages unrivalled by any other known source of heat.

Carbonaceous material, such as coal or wood, is practically inert to oxygen at ordinary temperatures; but if wood is heated to 295°C. (593°F.), or coal to 326°C. (617°F.), according to experiments by M. Marbach, combination takes place between the fuel and the oxygen of the atmosphere, giving rise to the phenomena of combustion. It is not necessary to raise the whole of the combustible materials to this temperature in order to continue the action. The very act of combustion, when once commenced, gives rise to a great development of heat—more than sufficient to prepare additional carbonaceous matter, and additional air for entering into combination. Thus a match suffices to ignite a shaving, and this in its turn to set fire to a building.

The first effect of combustion is, therefore, to heat the combustible, and the air necessary to sustain combustion, to the temperature of ignition; but in dealing with the combustible called coal, other preparatory work has to be accomplished besides mere heating, in order to sustain combustion. The following is an analysis, from Dr. Percy's work on "Fuel," of a coal from the Newcastle district—

Carbon	81.41	Nitrogen	2.05
Hydrogen	5.83	Sulphur	0.74
Oxygen	7.90	Ash	2.07

This shows at a glance that nearly 16 per cent. of the total weight consists of such permanent gases as hydrogen, oxygen and nitrogen. These gases are partly occluded or absorbed within the coal, but are also combined with carbon, forming volatile compounds, such as the hydrocarbons and ammonia; so that when coal is subjected to heat in a closed retort, as much as 34 per cent. passes away from the retort in a gaseous condition and as vapor of water, partly to condense again in the form of tar and ammoniacal liquor, and partly to pass into the gas mains as illuminating gas—a mixture mainly of marsh gas (CH_4), olefiant gas (C_2H_4), and acetylene (C_2H_2); its value as an illuminant depending upon the percentage of the last two constituents, rich in carbon. The results of the distillation of a ton of coal will be as follows, from data with which Mr. Alfred Upward has kindly supplied me—

	Cwt.
Coke	13.60
Tar	1.20
Ammoniacal liquor	1.45
Gas	3.15
Carbonic acid	0.18
Sulphur, removed by purifying	0.30
Loss	0.12

So great is the loss of heat sustained in an ordinary coal fire, in consequence of the internal work of volatilization, that such a fire is scarcely applicable for the production of intense degrees of heat, and it has been found necessary to deprive the coal in the first place of its volatile constituents (to convert it into coke), in order to make it suitable for the blast furnace, for steel making, and for many other purposes where a clear, intense heat is required.

In the ordinary coke oven the whole of the volatile constituents are lost, and each 100 lbs. of coal yield only 66 lbs. of coke, including the whole of the earthy constituents, which on a large average may be taken at 6 lbs., leaving a balance of 60 lbs. of solid carbon. In burning these 60 lbs. of pure carbon 220 lbs. of carbonic anhydride (CO_2) are produced, and in this combination $60 \times 14{,}500 = 870{,}000$ heat units (according to accurate determinations by Favre and Silbermann, Dulong, and Andrews) are produced.

The 34 per cent. of volatile matter driven off yield—when the condensable vapor of water, ammonia, and tar are separated—about 16 lbs. of pure combustible gas (being equal to about 10,000 cubic feet per ton of coal), which in combustion produce $16 \times 22{,}000 = 352{,}000$ heat units. The escape of these gases from the coke-oven constitute a very serious loss, which may be saved to a great extent, at least, if the decarburization is effected in retorts. The total heat producible from each 100 lbs. of coal is in that case $870{,}000 + 352{,}000 = 1{,}222{,}000$ or 12,220 units per pound of coal. Deduction from this must however, be made for the heat required to volatilize 34 lbs. of volatile matter for every 100 lbs. of coal used, and also for heating the coke to redness, or say to 1000°F. Considering the multiplicity of gases and vapors produced it would be tedious to give the details of this calculation, the result of which would approximate to 60,000 heat units, or 600 units per pound of coal treated.

We thus arrive at $12{,}200 - 600 = 11{,}600$ heat units as the maximum result to be obtained from one pound of best coal. Considering, however, that the coal commonly used for industrial purposes contains more ashes and more water than have been here assumed, a reduction of, say, 10 per cent. is necessary, and the calorific power of ordinary coal may fairly be taken at 10,500 units per pound.

In supplying this standard of efficiency to actual practice, it will be found that the margin for improvement is large indeed. Thus in our best steam engine practice we obtain one actual horse power with an expenditure of two lbs. of coal per hour (the best results on record being 1.5 lbs. of coal per indicated horse power). A horse power represents $33{,}000 \times 60 = 1{,}980{,}000$ foot pounds per hour, which is $1{,}980{,}000 \div 2 = 990{,}000$ foot pounds, or units of force, per pound of fuel. Dr. Joule has shown us that 772 foot pounds represent one unit of heat, and one lb. of coal therefore produces $990{,}000 \div 772 = 1282$ units of heat, instead of 10,500, or only one-eighth part of the utmost possible result.

In melting steel in pots in the old-fashioned way, as still practised largely at Sheffield, 2½ tons of best Durham coke are consumed per ton of cast steel produced. The latent and sensible heat really absorbed in a pound of steel in the operation does not exceed 1800 units, whereas 2½ lbs. of coke are capable of producing $13{,}050 \times 2.5 = 32{,}625$ units, or 18 times the amount actually utilized.

In domestic economy the waste of fuel is also exceedingly great; but it is not easy to give precise figures representing the loss of effect, owing to the manifold purposes to be accomplished, including cooking and the heating and ventilation of apartments. If ventilation could be neglected, close stoves such as are used in Russia, would unquestionably furnish the most economical mode of heating our apartments; but health and comfort are, after all, of greater importance than economy, and these are best secured by means of an open chimney. Not only does the open chimney give rise to an active circulation of air through the room, which is a necessity for our well-being, but heat is supplied to the room by radiation from the incandescent material, instead of by conduction from stove surfaces. In the one case the walls and furniture of the room absorb the luminous heat rays, and yield them back to the transparent air; whereas in the latter case the air is the first recipient of the stove heat, and the walls of the room remain comparatively cold and damp, giving rise to an unpleasant muddy atmosphere, and to dry rot or other mouldy growth. The adversaries of the open fireplace say that it warms you on one side only, but this one-sided radiant heat produces upon the denizens of this somewhat humid country, and indeed upon all unprejudiced people, a particularly agreeable sensation. This is proof, I think, of its healthful influence. The hot, radiant fire imitates, indeed, the sun in its effect on man and matter, and before discarding it on the score of wastefulness and smokiness, we should try hard, I think, to cure it of its admitted imperfections.

If incandescent coke is the main source of radiant heat, why, it may be asked, do we not at once resort to coke for our domestic fuel? The reasons are twofold—the coke would be most difficult to light, and when lighted would look cheerless without the lively flickering flame.

The true solution consists, I venture to submit, in the combination of solid and gaseous fuel when brought thoroughly under control, by first separating these two constituents of coal. I am bold enough to go so far as to say that raw coal should not be used as fuel for any purpose whatsoever, and that the first step towards the judicious and economic production of heat is the gas retort or gas producer, in which coal is converted either entirely into gas, or into gas and coke, as is the case at our ordinary gas works.

[To be Continued.]

—London *Journal of Gas Lighting*.

The Question of awarding the contracts for street lighting in Brooklyn has not been settled.

The Output of coal in Nova Scotia last year was 1,032,710 tons, against 788,271 tons the preceding year, and the sales were 954,659 tons, as against 688,626 tons in 1879.—*Ibid.*

The third Seam opened by the Halifax Company, Albion mines, has proved a very good coke and steam coal, and it is proposed to drive two slopes, with a solid rib of coal between, to have separate systems of ventilation, and one engine to hoist from both slopes. The Spring Mill, Cumberland mines are very busy. Shipped during December 11,200 tons of coal, and during January 10,500 tons.—*Coal Trade Journal.*

[Official Report.]

Eleventh Annual Meeting of the New England Association of Gas Engineers.

Held at Boston, February 16th, 17th, and 18th, 1881.

Morning Session.

The Association was called to order at ten o'clock A.M., by the President, William A. Stedman, Esq., of Newport, R. I.

The following members responded to the roll-call :

William York.	William D. Cadwell.
A. M. Norton.	Charles F. Warren.
John Andrew.	Horace Allyn.
John H. Burnham.	George D. Bill.
George D. Cabot.	Oliver E. Cushing.
H. F. Coggshall.	David W. Crafts.
C. W. Cochrane.	Charles S. Colbath.
H. S. Crowell.	George Dwight.
William B. Durfee.	W. H. Frost.
W. W. Greenough.	Lyman P. Gerould.
M. S. Greenough.	Edward Jones.
Milton Jewett.	Edwin Keith.
Charles D. Lamson.	David Moore.
George L. Manchester.	George B. Neal.
Thomas J. Pishon.	J. F. Rogers.
J. H. Rollins.	Charles F. Spaulding.
Isaac R. Scott.	J. Q. A. Spear.
Aaron Thompson.	Dudley D. Tilton.
J. R. Todd.	F. C. Sherman.
Gideon Wood.	Eugene H. York.
Samuel G. Stiness.	William A. Stedman.
A. B. Slater.	Charles F. Smith.
William H. Bradley.	John P. Harbison.
Charles H. Nettleton.	

On motion of Mr. Stiness, the reading of the minutes of the last annual meeting, and also of the last semi-annual meeting, was dispensed with, the same having already been published in the American Gas Light Journal.

The Secretary—There is in the city, and in this building, a gentleman whom we all know—Mr. William H. Price, the President of the American Gas Light Association. I have no doubt all would be happy to have him with us. The Secretary of that Association—Mr. W. H. White—and Mr. Flemming, who succeeded Mr. Edge as engineer of the Jersey City Gas Works, are also here. I suggest that a committee be appointed to wait upon those gentlemen and invite them to meet with us and take part in our proceedings.

The President appointed Messrs. Stiness and Greenough a committee to wait upon the gentleman named and invite them to be present at the meeting of the Association.

The committee retired, and presently escorted the gentlemen to the room.

Mr. Stiness—Mr. President, I have the pleasure of presenting to you Mr. Price, of Cleveland, the President of the American Gas Light Association; Mr. Flemming, of Jersey City; and Capt. White, the Secretray of the American Association, who has often met with us.

The President—Gentlemen of the Association : I am happy to introduce to you Mr. Price of Cleveland, the President of the American Gas Light Association; Mr. Flemming, who succeeded Mr. Edge as manager of the Jersey City Gas Works; and Capt. White, who is the Secretary of the American Gas Light Association, and whom you all know. I am sure we are all very glad that these gentlemen have been able to time their Eastern visits in such a way as to be able to be present at our meetings.

The Secretary—The next business in order being the election of new members, I will report that at a meeting of the Directors, applications were received from the following gentlemen, whom the Directors unanimously propose for membership :

John Cabot, Lawrence, Mass.
Edward C. Jones, South Boston, Mass.
C. F. Prichard, Dedham and Hyde Park, Mass.
Robert B. Taber, New Bedford, Mass.
David Boynton, Chicopee, Mass.
Samuel Fowler, Westfield, Mass.
W. H. Snow, Holyoke, Mass.
Charles S. Spaulding, Brookline, Mass.
W. B. Durfee, Jr., Fall River, Mass.

On motion of Mr. Stiness, the Secretary was authorized to cast the ballot of the Association for the gentlemen above named; which having been done, they were declared unanimously elected to membership.

All excepting Mr. Boynton appeared, were introduced to the Association, and took their seats as members.

Address of the President.

Gentlemen of the Association:—I congratulate you that we meet again after a year of fairly successful business. I trust we are come together with the determination to promote the interest and advantage of our meeting by the closest comparison of our experiences, failures as well as successes. Let us resolve at the outset to give and gain by the fullest and frankest interchange of the records of our past results, and the discussion of expected or hoped for improvements in the future.

A problem was given us by a member at our last meeting, viz., how to be able to sell gas at about $1 per thousand and pay dividends. I hope our discussions and papers will show that we have made good progress toward its solution. The longest stride in this direction would be made by materially increasing the yield of gas per ton of coal. In point of saving—that is, in reducing the cost of gas in the holder—an increased yield of 1000 feet per ton does not show the ultimate advantage. Indeed, it can be demonstrated that such increased yield might result in a loss if it were attended by an increased consumption of coke and a slight diminution of candle power. In point of gaining, however, such increase gives very satisfactory showing. For example, suppose coal to cost $5 per ton and gas to be sold at $2 per 1000 ; in point of saving, if we had made 10,000 feet per ton, the gas has cost for coal alone 50 cents per thousand ; at a yield of 11,000 feet, the cost is 45.55 cents ; and at 12,000 feet, the cost is 41.66 cents per 1000 —a saving which could possibly be realized as well by the greater economy attendant on the smaller yield. But when the increased receipts from each ton of coal are considered, it will be seen that the gain in the two cases would be $2 and $4 respectively—amounts which would far exceed possible results in the economy of fuel and utilization of residuals.

The important factor in the dollar problem is, both to the engineer and the stockholder the question of dividends. If the dividend gets one-half of the dollar (and it would seem that capital should be so adjusted to business as not to exact more than 50 cents per thousand on the yearly sales), there would be left us the simpler, and, judging by the figures of our statistics for 1878, the quite simplified problem of making gas at 50 cents per 1000 and paying expenses, and keeping of our plant and mains in condition, and even of sometimes improving their condition and extent. Now we need to look sharply after all the economies of manufacture, and while trying to get the most 17-candle gas with the least enriching expense we want to utilize the residuals in the closest and most effective manner.

Thanks to the earnest souls who have led the way in the investigation of better methods of firing, we have complete demonstration of possibilities in the economic application of heating. There appears to be on both sides of the water an acceptance of the Siemens theory—of a primary partial combustion and a subsequent complete oxidation of the products obtained by the first process, by means of a supplementary supply of heated air. This method is scientific, logical, and, in its application to our work, as well as in many other manufactures, proves itself eminently practical. It eliminates many elements of uncertainty which the old method of direct combustion involved. As doubtless you have all given the subject much thought and observation since our last meeting, I need not dwell upon its general features.

In the last number of the American Gas Light Journal was figured the plan now in use at the South Metropolitan Works in London, and this plan seems to have points in advance of anything yet promulgated in compactness, simplicity, and economy of results. The introduction of steam at the grate bars and the subjection of the intense and destructive heat generated at that point, by causing such heat to expend a portion of its energy in the decomposition of steam, and thereby diverting said energy from its usual work of decomposition of the bricks lining the coke chamber, the reduction of the slag and clinker nuisance to a minimum, the utilization of the products of the decomposed steam at a point where their combustion is only beneficial—these are great and easily appreciated advantages. If Mr. Livesey gains the step further which he proposes to take, and utilizes his waste heat in raising to the highest possible point his supplementary air supply, it would appear that very little would remain to be done to reach the ultimate of economy in the application of heat to the distillation of coal.

Now that we are in a hopeful mood in relation to our possible economies of manufacture, we will, if you please, regard the ultimate of economy within our reach, and look at the coke question thus: One ton of coal will produce 40 standard bushels of coke ; of this amount 12½ per cent. suffices to carbonize, and we have 35 bushels of coke, at, say, 7 cents per bushel, to the credit side of gas in holder. Now, if our enthusiastic friend, who has twice favored the American Association with addresses on coal tar and its products, shall be able to make the world see the rosy colors which he extracts, the result must be to our advantage in disposing of our product,

which, in spite of the gorgeous hues we know it contains, remains in our estimation a nasty black nuisance. Let us hope that its value will increase, and that at least we may be able to realize 5 cents per gallon in the not distant future. Then the 12 gallons which we may be able to gather will leave 1 gallon for each 1,000 feet, and will carry another 5 cents to the right side of the account. Of course, we all know that our ammoniacal liquor is soon to become valuable. Let us suppose that from this source 4 cents can be credited. Then—

12,000 feet of gas, with coal at $5 per ton, gives the cost of 1,000 feet		41.66 cents.
35 bushels coke, at 7 cents=$2.45÷12=20.41 cents.		
Tar 5 cents and ammonia 4 cents	9.00 "	
		29.41 cents.
Coals less residuals		12.25 cents.
Add for labor and salaries at works	10 cents.	
Purifying	1 "	
Retorts and tools	2 "	
Repairs of plant	5 "	
Repairs of mains and meters	2 "	
Management	6 "	
Rent and taxes	3 "	
		29.00 cents.
Total cost of gas delivered to consumers		41.25 cents.

Leaving a margin of 8¾ cents for leeway and leakage. The problem is solved—on paper.

The small cost of labor and salaries at works, viz., 10 cents per 1,000, is to be obtained by the general introduction of mechanical stoking, in connection with the Siemens furnaces. By the same furnaces and improvements in settings, it is to be hoped that a lower sum even than 2 cents will represent the per 1,000 cost of retorts. The repairs of plant item is a varying quantity, but the proportionate figure will be diminished as the productive capacity of the plant is more completely utilized. The repairs of mains, rent, taxes, and management items will be lessened as to per 1,000 cost in consequence of the great increase of sales resulting from the low price of gas.

At the last August meeting of the Manchester District Institution of Gas Engineers, which was held at the Halifax (England) Gas Works, the President, in the course of his address, gave an analysis of the cost of gas at his works the previous year. He stated the yearly consumption to have been 277,000,000 feet. Calling a penny 2 cents in our currency,

His coal and cannel was per 1,000		23.20 cents.
His residuals netted		20.18 "
Coals less residuals		3.02 cents.
Salaries and wages	12.20 cents.	
Purifying material	.60 "	
Maintenance of retorts	2.96 "	
General workmen, repairs, etc.	4.28 "	
Miscellaneous expenses	3.70 "	
Rates and taxes	5.92 "	
	29.66 cents.	
Less meter rents	3.44 "	
		26.22 cents.
Cost of gas at consumers' meters		29.24 cents.
Received per 1,000 sold		74.90 "
Profit		45.66 cents.

You will notice a different division of the expenses from the hopeful and hypothetical case previously mentioned. And of course our hypothesis does not come near his actual results. The differences can readily be compared and the points of approximation and irreconcilability can be easily seen.

In relation to durability of retorts, there seems to be a wide range in the different works. Six months is mentioned as the average life in some places, while in others several years are passed in using the same bench. While writing this, a copy of results in working the same benches several years lies at hand, and tempts the use of some of its figures. The longest firing was 970 days, and the greatest product per retort was 6,986,000 feet, or 41,916,000 feet per bench. Supposing the retort and setting to have cost originally $300, the result would show a cost of about ¾ cent per thousand feet of gas to renew the bench. With the new method of firing, with the greater steadiness of heat maintained, and the immunity from cold blasts, in connection with the closer blocking of the retorts in their places, which is not only possible but desirable, there need be but intelligent care directed to proportion the charges to the heat carried, to enable retorts to be worked through a useful life to a reputable old age. In large works the adapting the charges to the heats is much more easily managed than where an idle retort bears such a large ratio to the whole number. It is certain that when retorts are worked full, with high heats, and not undercharged, they give their best results in quantity, quality, and freedom from stoppages and annoyances. On the other hand, where charges are necessarily very variable, unless the heats are very intelligently managed the retort soon becomes damaged, and carbon and pitch and soot and tribulation ensue. The preponderance of testimony in relation to anti-dip valves is rather to the effect that their influence is against the health of the retort. The deduction is so obvious that I need not make it. Ambitious engineers who tip the water in the gauge the wrong way in their eagerness after big yields can readily see the point.

The main points in standpipe stoppages were well discuseed at the Chicago meeting without definite settlement. There are plausibilities on both sides of the question. We can remember—at least we older ones—that the low heats with iron retorts did not give us entire exemption. But we know that high heats and hard burning have increased our troubles manyfold. Cooling the standpipes has proved an effectual remedy with many; but no remedy will prove complete if charges are forced too hard. Lewis Thompson pointed out 20 years ago, in a little book he published, the limitation in the direction of squeezing the coal. "Whenever," said he, "with the ordinary process, you extract such a portion of the naphthas or light oils from the tar as to leave the balance without sufficient fluidity to be easily run off, your difficulties in managing it will be greater than the advantage of an increased yield."

It is quite among the common experiences to have a pitchy tar to deal with, and still to wonder where are the light oils that should have kept it lubricated up to an ability to do its own locomotion, in connection with the persuasive allurements of gravity. The pitch we have, the naphthas and light oils—where are they? The gas didn't get them, because neither the quantity nor quality justifies the assumption of their gaseous conversion. They have gone while in vapor beyond the main, and condensed further on. The radient heat from the bench and the high temperature of the gases and vapors in the main have prevented condensation, and the liquids which might have assimilated the thirsty lampblack have gone. Then, when things on the main present a threatening aspect, and you expect soon to shut down and open your hand-holes to pull out the pitch, why not pump up some of the thin tar from the condenser and have it run slowly into the main from such a position that it will thoroughly mix with the contents thereof. This has often been done with gratifying results when the patient was not too far gone.

A new hydraulic is on the market which admits of all objectionable matter being removed without stopping carbonization; and the gas is entirely sealed off during the time the main is open. It is exceedingly simple, and offers possible consolation to those who will make pitch occasionally.

When we leave the retort house we leave the most fruitful subjects of discussion. Beyond the domain of the stoker, things act a little more as if amenable to some natural laws, always excepting that outlaw, bummer, guerrilla, or whatever bad name it may get—naphthaline. There is some interest in the results of trials in purification with a new applicant for favor called iron sponge. You will doubtless be favored with some figures in regard to its value by the members who have already given it a trial.

In a recent number of the London *Journal of Gas Lighting* two pages are taken up with certificates of the value of a scrubber called the "Standard," and already some time in use at various places in England. A list of the works using it is included in the advertisement, and among them appears "Newport, U. S. A." This does not locate the machine very definitely, but it is known very well what Newport is meant when it is considered only necessary to add "U. S. A." Of course it means *the* Newport, and although the machine has been running since last Friday morning only, such observations on its behavior as could be made in the short time since then will be laid before the meeting later on.

To generalize at the close of my remarks, let it be understood that the problem recalled to your minds is not to be dismissed with the conundrum answer, "I give it up." It is presented in all seriousness as a problem to be solved. It is one of the problems of our lives, if we continue as gas engineers. It is going to be solved presently. Shall we each contribute our quota of hard thought and hard work to the question, that our sum of knowledge may accumulate from the individual mites.

The rivals for public favor in artificial illumination are restless and pushing. They work hard to win the position we occupy. Shall we fortify ourselves by making our product the cheapest, as it is the best, for all purposes of lighting? Shall we push our consumption into the domain of heating and cooking, by offering the boon of gaseous fuel at prices which will compete with and displace solid fuel?

To do our best, we must work and think. Decide carefully on the best thing offered to advance your business, and when you have decided, have that thing as soon as you can compass it. Throw out any apparatus or

method that obstructs or hinders your progress to the highest success. You cannot afford to retain what you know hinders the best results. It pays to get the best, and when that is improved upon, discard it and get the improvement. Only be sure it is an improvement before you exchange the old love for a new.

And be social, communicative, and compare notes assiduously, not only here, but anywhere you meet. Visit each other's works and make observations. When you come, then, to the yearly meeting, you will be full of question and instructive reply. Whatever is presented here, discuss it to shreds. We accomplish the confirmation of our judgments and have our fallacies exploded by the friction of intellect. The sympathy evoked in a common cause, the friendship springing from the sound basis of mutual respect and esteem, the very consciousness of being one of the solid and intelligent body that represents the interests of New England in a business so closely identified with household comfort and convenience; these are considerations which are worth the time and effort of attendance at our reunions. But no member can come to a session and listen and take part with a desire to benefit himself in his knowledge of his profession without feeling munificently repaid. One man don't evolve all knowledge from his own brain. What he gathers is by far the larger part of his attainments, be he never so original or profound.

On motion of Mr. Stiness the thanks of the Association were "tendered to the President for the very able and instructive address which he had delivered."

READING OF CORRESPONDENCE.

The Secretary read letters from the following gentlemen, regretting their inability to be present:

Mr. William C. Taber, the oldest member and one of the founders of the Association; Mr. Edwin Ludlam, President of the Peoples Gas Light Company, of Brooklyn, N. Y.; Mr. Thomas Turner, President of the Charleston (S. C.) Gas Light Company; Mr. A. C. Wood, President of the Central New York Association; Mr. Charles Nettleton, late Secretary of the American Gas Light Association; Mr. Eugene Vanderpool, of Newark, N. J.; Dr. T. O'Connor Sloane, of the Citizens Gas Light Company, of Brooklyn, New York; Thomas Butterworth, President of the Western Association of Gas Engineers, and others.

TREASURER'S REPORT.

The Treasurer presented and read his Annual Report, together with the Report of the Auditing Committee certifying to its correctness—

Balance as per last report	$ 7.73
Received for 73 annual assessments	219.00
" " 2 admission fees	10.00
" " interest from savings banks	40.40
Total	277.13
By paid sundry expenses	311.51
Balance due Treasurer	$ 34.38

INVESTMENTS.

Charleston Five Cents Savings Bank	$500.00
Warren Institution for Savings	500.00
	$1000.00

To the above was appended the report of the Auditing Committee, Messrs. Gerould and Spaulding certifying to the correctness of the same.

On motion of Mr. Stiness it was ordered that the Report of the Treasurer and of the Auditing Committee be received and placed on file.

REPORT OF THE COMMITTEE ON STATISTICS.

The President—As Chairman of the Committee on Statistics, I will report that we have compiled answers to a small number of questions sent out to the members. The questions were purposely kept few in number in order that there might not be the slightest objection to answering any of them; and we hoped to get complete returns. We have here about forty answers, more or less complete—some of them are quite complete. The answers have been tabulated and printed, and copies are on the table ready for distribution.

The efforts of the Committee on Statistics have been supplemented by the efforts of the United States Government, personified in our friend, Major Dresser. He is about to collect statistics; and a reference to the questions which he has addressed to every member shows that they are quite as pertinent as anything that the Committee on Statistics ever sent out. He has the advantage of having ample authority behind him by means of which he can secure proper returns. In view of what we may expect from the compilation that Major Dresser is about to make, I would suggest that the Committee on Statistics be discharged.

Mr. Stiness—I hope not. When this matter comes up under the head of general business, I would like to discuss it. I hope the Committee will be continued.

The President—It is quite possible, if Major Dresser will lend us his figures when he gets them completed, that the Committee will be able to make a satisfactory report. I have not consulted with the other members of the Committee with reference to being discharged. It is possible that they desire to be continued in service for some time longer. In that case I suggest that a new chairman be appointed.

Mr. Stiness—I have not heard any of them request to be discharged.

The President—As a member of that Committee my labors have not been particularly arduous. I have sent to each member a list of questions, with a request that they be returned with such additions or alterations as they thought proper. From the returns received in that way we compiled the present quite inoffensive list. They do not embody a great deal of information; but it is such information as is sometimes wanted, and it is only to be obtained after a considerable amount of correspondence, more or less irksome and extensive. I have no personal objection to serving on the Committee again, except that I think we have about finished our career of usefulness. Does Major Dresser expect to get out his statistics in this decade, or later?

Major Dresser—There is nothing "decayed" about them, so far as I am concerned.

The President—I know that reports from the Census Office are sometimes very much delayed. I do not know whether or not it is in the power of Major Dresser to facilitate the publication of these particular statistics.

Major Dresser—If *all* the members of the gas fraternity so desire, I presume that arrangements can be made to publish each one of the returns in detail (laughter), instead of publishing them in the aggregate, consolidated by States, as it is now proposed to do it. It is possible that advance copies of the returns, when consolidated, might be obtained for publication. Or, so soon as the returns are completed, a summary of them might be published in the same way as other census intelligence, viz., by bulletins. It is not probable that the compilations can be completed and finished before next Autumn.

The President—If the Committee on Statistics is continued they will endeavor to do something to merit the continued confidence and esteem of their fellow associates. They have not done a great deal in the past two years because, as you will recollect, there was a little hitch about the very full returns published two years ago; and from the manifest impossibility of keeping them as quiet and *sub rosa* as some of the members desired, it was thought impossible for the Committee ever again to secure anything quite as complete as were those returns. The statistics have, therefore, run down to the present very diminished form. I do not suppose that it would be possible to get any better returns for another year; but I have no objection, if the other members of the Committee have none, to being continued for another year, although I cannot promise any better results.

THE AMERICAN GAS LIGHT ASSOCIATION.

Mr. Stiness—It is well known to all of the members of this Association that the annual meeting of the American Gas Light Association is to be held in Boston, next October. I feel that it is a duty which the New England Association owes to itself that a recognition of that fact should be made, and that this Association as a body should take cognizance of that meeting. Although the recommendation of the directors in this regard is not exactly what I had framed in my own mind, I will read what I have written, and then the members can determine what action they will take. I would empower the Committee to do what they please in the matter. I believe that the New England Association should make it a distinctive feature of that meeting that one day be set apart for the express purpose of giving to our friends and brothers of the American Association a New England welcome to the city of Boston. They have been greeted in the many cities where they have met with hospitality, friendship and kindness; and I desire that our friends may know that we have, in New England, hearts as as warm and a welcome a cordial as any in western or southern cities. I, therefore, offer the following:

Resolved, That a committee, consisting of the President, and such others as he may appoint, be authorized to make such arrangements as they may deem expedient for the reception and entertainment of the American Gas Light Association, in the city of Boston, in October, 1881.

Ordered, That the committee be authorized to draw from the treasury a sum not exceeding —— dollars, to meet the expenses of said committee.

I believe that it is better to appoint a judicious committee, and let them make such arrangements as they please. The American Association has appointed such a committee. The two committees can agree on any arrangements which may be made.

As the American Association meets in Boston, in October, it occurs to me that it might be a matter of policy to omit the semi-annual meeting of this Association next August. For that reason I say nothing in my resolution about having the committee report at the semi-annual meeting. I believe, as I have already said, that a committee, consisting of the President, and

such others as he may appoint, can make arrangements which will be perfectly satisfactory to the Association, which will be a credit to ourselves, and a pleasure to our friends.

I offer the resolution which I have read; but if the Association prefers to adopt the course which the directors have recommended, I am content.

The Secretary—The recommendation of the directors was made merely with a view of bringing the matter to the notice of the Association; and, of course, any member has a right to offer any resolution that he pleases. The matter is merely brought before the Association for their notice.

Mr. Stiness—I left a blank in the resolution, in order that the Association may fix the sum which it will authorize the committee to expend. There will be certain expenses which it will be necessary to pay from the treasury. I leave it to the Association to say to what extent the committee may go in the expenditure of money.

Mr. Harbison—I will say that at the meeting of the directors last night it was proposed to recommend such a course as Mr. Stiness has proposed; but it was queried whether the Association would be willing to vote a sum of money to the control of the committee without knowing something about how much would be needed. It was thought by the directors that, after a conference with the committee from the American Association, our committee would be able to report, at the semi-annual meeting in August, just what sum would be required. But if the Association is now prepared to name the amount which they are willing to appropriate for this purpose, the matter may as well be finished up at this time. Of course, it would be better to finish it up to-day if it shall be thought desirable to carry out the suggestion which has been made, and omit the semi annual meeting.

Mr. Stiness—My idea in suggesting the omission of the semi-annual meeting was that every member of the New England Association desires to be here in October; and it may not be convenient for many of them to attend in August and also in October. If our semi-annual meeting is omitted it will give all the members an opportunity to attend in October; and it is desirable that all of our members should contribute as liberally as they can towards the entertainment which we propose to offer to the American Association.

In regard to the sum of money to be appropriated—of course I can only give my ideas. I would be willing to leave it entirely to the committee or to the board of directors. I have no objection to giving them a limited sum, and then if they desire more I have no doubt there are many members who would willingly contribute out of their own pockets for the purpose of making the entertainment a success. I would like to have the Association express an opinion as to how far they are willing to go in the appropriation of money for this purpose. If appointed now, the committee will have ample time to consult with the committee of the American Association, and to complete their arrangements.

The Secretary—It was suggested, at the meeting of the directors, that the matter be left with them; and I think that that would be the best course to pursue. I would suggest, as a motion, that the whole subject be left with the board of directors, with full powers, and that they be authorized to expend ——— dollars for the purpose. I cannot fix the sum. Of the committee of the American Gas Light Association, Mr. M. S. Greenough is Chairman, and Messrs. Slater, Rollins, Cushing and myself are members.

Mr. Stiness—I have no objection to that course, provided the board of directors can know how much money they can have to use. I should not like to give them power to draw out the whole of our fund; but I should like to let them know how far they can go in the expenditure of any money.

Mr. Spaulding—Would it not be well to limit them to an expenditure of $500 from the funds of the Association?

Mr. Stiness—I would like to ask the Treasurer whether there is any money that can be drawn upon for this purpose?

The Treasurer—There are 34 dollars due the Treasurer. That cannot be drawn. (Laughter.) The Treasurer claims the right to draw that amount from the first funds coming in. There are some seventy members, and $45 worth of new members. That indicates the amount that we shall have on hand. We cannot draw from the permanent fund except by vote of the Association.

Mr. Stiness—Are the invested funds of the Association in such a condition that they can be drawn from by the vote of the Association?

The Secretaay—They can be drawn upon at any moment by vote of the Association.

Mr. Stiness—My idea in offering the resolution providing for the appointment of a committee was to cover the point made by a vote passed sometime ago to the effect that this fund cannot be drawn upon by the board of directors, unless by direct vote of the Association. I think those funds are so tied up that it requires a direct vote of the Association authorizing some person to draw the money. Can the Treasurer state whether the money is so tied up?

The Treasurer—It cannot be drawn except by a vote of the Association.

Mr. Stiness—That is what I thought; and, therefore, I offered that resolution,

Mr. Lamson—Is there any motion before the meeting?

The President—The motion of Mr. Stiness.

Mr. Lamson—I was going to move that the whole matter be left to the board, with power to draw $500.

The Secretary—I would suggest that the whole subject be referred to the directors, with full powers to make all necessary arrangements for the entertainment; and that a sum not exceeding $500 be drawn from the permanent funds of the Association for that purpose.

Mr. Harbison—I think that we had better not go too fast with this thing. I do not dnow whether it is fair treatment of the committee appointed by the American Association, for the New England Association to step in at this point, and, as might appear on the face of it, take the entertainment of the American Association upon their own shoulders, and leave the committee of that Association out in the cold. Before we take any definite action toward the entertainment of the American Association, we had better have a conference with the committee appointed by that Association for that very purpose, and cooperate with them. Perhaps there has already been sufficient means raised by that committee for the abundant entertainment of that Association when they meet here. It seems to me that it would be better to-day to appoint a committee to confer with that general committee, and ascertain what will be agreeable to them; and then before we adjourn we can take the matter up again, and appropriate whatever money our committee may determine will be needed. Let us learn first what has been done by an already appointed committee, who are certainly as efficient as any that can be named. I merely throw this out by way of suggestion.

Mr. M. S. Greenough—As one of the committee appointed by the American Association in this matter, I will say that nothing has yet been done by that committee, nor do I think that they have at all considered the question. I think that the appointment of a committee by this Association would be eminently proper. I do not think the thing has yet been put in just the shape in which it should be left. When the time draws near for entertaining the American Association, the committee appointed by that body will, I presume, see how much money they can raise. I think that a committee should be appointed by this body to confer with that committee of the American Association, and that the committee of this body should be authorized to draw, if necessary, $500 from the funds of this Association toward entertaining the American Association. It seems to me, however, that it will not be necessary to use any such sum of money as that. There is no need of taking the funds of this Association if we are able to raise what money we need from other sources; but I think that this committee should be authorized to draw up to that amount, in case the other committee should call on them to do so. I think that the Board of Directors of this Association contains three or four members of the National committee, so that practically they form one committee. I think that it will do very well if we put it in this way: That a committee, consisting of the President and Directors, be appointed to confer with the committee appointed by the American Association, and to make such arrangements as they may deem expedient for the reception and entertainment of the American Association; and that the committee be authorized to draw from the permannnt funds of this Association a sum not exceeding $500 for that purpose.

The President—I presume that the idea of Mr. Stiness was to provide for some distinguishing features of the entertainment which should be recognized as being a New England welcome.

Mr. Stiness—That was my idea. Knowing that some of our members were also upon the committee of the American Association, and would perhaps have about as much to do as they could well attend to, I thought it might be well for us, as an Association, to tender to our visitors a banquet, for instance, as distinct from the entertainment which the committee of that Association might provide. I supposed, of course, that any committee which we might appoint would confer with the other committee and act in entire harmony with it. I would not attempt to interfere in any way with the arrangements of the general committee; but I would like to see the matter so arranged that a distinctive feature of the entertainment should be a New England welcome by this Association to our friends and visitors of the American Association. I would put this welcome in the form of a banquet, tendered by the New England Association, in addition to the reception which the committee shall tender. I would hope that no money need be drawn from the Association fund for that purpose. I have no doubt, if a committee be appointed, they will be able, by subscriptions from individual members, to obtain an amount sufficient to cover all needed expenditure. Perhaps it would be well to postpone this matter until to-morrow in order that members may have opportunity in the meantime to think and talk it over. I therefore move that my motion be laid on the table for the present.

The motion was agreed to.

[To be continued.]

[From the London "Journal of Gas Lighting."]

Observations on Glass as an Obstructor and Reflector of Artificial Light.

By Mr. F. W. Hartley, A.I.C.E.

First Article.

In the *Journal* for Feb. 28, 1860, there appeared an interesting letter from Mr. W. King, of the Liverpool United Gas Company, containing the results that he obtained in certain experiments with burners and glass globes or shades, and with a sample of sheet glass. The particulars given were as follows:

	Loss of Light.
Clear glass (globe or moon)	10.57 per cent.
Ground glass—entire surface ground	29.48 "
Smooth opal	52.83 "
Ground opal	55.85 "
Ditto, ornamented with printed figures, the figures intervening between the burner and the photometer screen	73.98 "
Common window glass	9.34 "

Mr. A. H. Wood, of Hastings, at a later date, I believe, also made experiments in the same direction as Mr. King has done, and the statements of his results, as given in Mr. T. Newbigging's "Handbook for Gas Engineers and Managers," are reproduced below:

	Loss of Light.
Clear glass globe	about 12 per cent.
Clear globe with slightly ground flowers	" 24 "
Globes of about the usual pattern	" 35 "
Globes ground all over	" 40 "
Opal globes	" 60 "
Painted opal globes	" 64 "
Common window glass	" 9 "

As far as I am aware, the statements of these two gentlemen embrace all the published facts upon this subject. It will be observed that there are considerable discrepancies between the results arrived at by the two experimenters; while both fail to give the diameters of the globes or moons operated with, the kind of burner employed, and the intensity or power of the unshaded or unscreened flame. I apprehend also that the determinations were based on the amount of light obstructed in a horizontal line coinciding, nearly or quite, with the central horizontal axes of the moons themselves. Results obtained under such a condition might be sufficiently near the truth in the days when moons with openings only 2½ inches in diameter at the bottom were universal (and even now, with the general run of Argand moons), but not when, as is at present the case, moons are used with the bottom openings 4 to 5 inches in diameter, and much light, therefore, is reflected downward through such openings. The value of this reflected light will be shown at the latter part of this article.

I have called attention to the discrepancies in the quoted statements. Mr. King says the loss with a globe ground all over is 29.48 per cent.; Mr. Wood, that the loss is as much as 40 per cent.; while with opal globes Mr. King's loss is 52.83, and Mr. Wood's 60 per cent. Truly Mr. Wood says "about" in each instance. That in such an investigation as is in question discrepancies should arise in results realized by two competent experimenters—working it may be on somewhat different lines, and with, it may also be, inconstant standards of different intensities—can be no great matter of surprise, and in no sense reflects discredit upon either. I have only mentioned the matter in order to show that the data at present accepted can scarcely be so exact as is to be desired.

During the past year, while working very much with Mr. Methven's standard, or light unit, an old scheme—and I think a French one—for the estimation of the power of flames of high intensity by the aid of a standard of low intensity, revived itself in my mind—namely, the reduction of the intensity of the powerful light by introducing between it and the photometer disc a series of transparent or semi-transparent plates of glass, the obstructive power of which for various distances and intensities of light had been determined. To successfully and readily apply such a system it was necessary to ascertain whether the obstructive power of glass plates varied in any regular ratio with their distances from a flame and with the intensity of the latter. After a number of experiments I was elated with the prospect of success, for the results obtained seemed to indicate that the resistance was proportionate to the cube root of the distance of the glass screen from the flame, plus or minus (I forget which, for I have lost my first notes) a constant difference. As, however, I was fully sensible of the fact that Dame Nature was charry of giving the discovery of a general principal or law, however simple, to any one of her children, until after he has proved himself a very slave to her, I doubted the possibility of her being so suddenly generous to me, and continued my inquiries with greater care. I was speedily disillusioned as regards the discovery of a "law," but the subject of inquiry had grown so interesting that I resolved to pursue it with humbler aims in view, although my project for a photometer was apparently shattered.

My experimental observations may be conveniently arranged under five headings, namely, the effects obtained with—

1. Clear sheet and plate glass.
2. Ground sheet and opal glass.
3. Globes and half globes as obstructors and reflectors of horizontal light.
4. Globes with elevated or overhead lights.
5. Reflectors, etc., with elevated or overhead lights.

Throughout the whole series of experiments Methven's light unit was employed as the standard of comparison; and, without its aid, it would have been impossible for me to make the tests with sufficient rapidity and certainty. In order, however, to avoid the risk of any error whatever, and although with each set of experiments every care was taken to insure a regular rate of consumption with the opposing burner, the constancy of the light given was verified by direct comparison with the Methven unit at very short intervals—immediately, in fact, between almost every trial with screens and globes. The experiments extended over several months, being made when circumstances permitted; many were repeated a number of times, and the results always agreed within one or two per cent., although the illuminating power of the gas used on various occasions differed to the extent of more than 1½ candles. In the first and second series the gas was adjusted to give a light of 13.5 and of 17.5 candles; these being deemed the extremes likely to be experienced in practice with the Argand.

CLEAR GLASS SERIES.

Table No. 1 (12-*oz. Sheet.*)

Light by Argand	13.4	13.4	13.4	13.4	13.4	13.4	13.4	candles.
Glass screen at	3½	8	10	12	15	18	20	inches.
Loss of light	10	11	11	12	12	12	12	per cent.
Light by Argand	17.5	17.5	17.5	17.5	17.5	17.5	17.5	candles.
Glass screen at	3½	8	10	12	15	18	20	inches.
Loss of light	12	13	13	15	15	17	17	per cent.

Other samples of sheet glass gave similar results, and it is needless, therefore, to tabulate them. The following, however, are of interest (Table No. 2). D is plate glass of the best quality, 5-16ths inch thick; No. 2 is 17-oz. sheet; E is 21-oz. cast glass, such as is used for gratings, coal-hole plates, etc.; and F is a corrugated plate with fine lines.

Table No. 2.

Light by Argand	17.5	17.5	17.5	17.5	17.5	17.5	17.5	candles.
Glass D at	3½	8	10	12	15	18	20	inches.
Loss of light	8	12	13	13	13	13	13	per cent.
Glass No. 2 (17-oz.), loss	11	13	14	15	16	16	16	per cent.
Glass E (21-oz.), loss	13	13	15	18	18	15	16	per cent.
Glass F (30-oz.), loss	19	19	20	20	23	27	27	per cent.

Very common sheet, loss 11 per cent.

It will be observed from the preceding tables that the loss with clear glass tends to be constant for any distance over 8 inches from the flame, that the percentage of loss increases as the light is increased in power, and that for equal intensity of light the thick plate, D, obstructs less light than ordinary sheet. This, no doubt, is to be attributed to the superior quality of the glass, the perfect parallelism of its surfaces, and their highly polished condition. Sheet E gives somewhat irregular results. This is due to its peculiar rough and indented surfaces, which may be likened to those of a plate of iron which has been roughly hammered over with a hammer having a slightly convex face, about 1½ inches in diameter. These hollows curiously resolve the light into bars or streaks of unequal intensity, which effect increases as the glass is receded from the light, and renders photometric estimations difficult. Some part of the irregularities of the preceding and following tables are due to the fact that I have limited the statements of percentage loss to the *whole numbers*. Hence some are slightly greater and some slightly less than were obtained in the experiments. I feel, however, that it would be little less than an affectation of refinement to carry the results of such experiments into decimal places.

GROUND GLASS SERIES.

Table No. 3 (16-*oz. Sheet*).

Light by Argand	13.5	13.5	13.5	13.5	13.5	13.5	13.5	candles.
Glass screen at	3½	8	10	12	15	18	20	inches.
Loss of light	26	51	54	58	61	62	62	per cent.
Light by Argand	17.5	17.5	17.5	17.5	17.5	17.5	17.5	candles.
Glass screen at	3½	8	10	12	15	18	20	inches.
Loss of light	24	38	41	44	47	51	51	per cent.

Table No. 4 (27-oz. Sheet).

Light by Argand.....	13.5	13.5	13.5	13.5	13.5	13.5	13.5	candles.
Glass screen at.....	3½	8	10	12	15	18	20	inches.
Loss of light	32	57	61	64	66	68	68	per cent.
Light by Argand.....	17.5	17.5	17.5	17.5	17.5	17.5	17.5	candles.
Glass screen at.....	3½	8	10	12	15	18	20	inches.
Loss of light	34*	48	49	52	55	55	55	per cent.

Table No. 5 (24-oz. Sheet).

Light by Argand.....	13.5	13.5	13.5	13.5	13.5	13.5	13.5	candles.
Glass screen at.....	3½	8	10	12	15	18	20	inches.
Loss of light.....	35	58	62	65	68	68	68	per cent.
Light by Argand.....	17.5	17.5	17.5	17.5	17.5	17.5	17.5	candles.
Glass screen at.....	3½	8	10	12	15	18	20	inches.
Loss of light.....	39*	48	50	55	58	60	60	per cent.

From Tables Nos. 3, 4, and 5, it will be seen that the percentage loss tends to be constant at distances of 15 inches and upwards from the burner, or at nearly twice the distance found for clear glass; while, contrary to what ensues with clear glass, the *percentage loss* diminishes as the light increases in power, the absolute loss of light being, however, greatest with the most powerful light. At 3½ inches distance the effects of the 27-oz. and 24-oz. sheets (Tables Nos. 4, 5) are somewhat exceptional, for with the strongest light a higher percentage loss is manifested than with the weaker light. These figures are, therefore, marked with asterisks. In the trials recorded in Tables Nos. 3, 4, and 5, the *ground* sides of the glass sheets were presented to the burner; but a circumstance led me to suspect that a difference would be found if the smooth instead of the rough side were presented to the flame. With the light from the Argand equal to 17.5 candles, the 16 oz. sheet (Table No. 3) was alternately presented smooth and rough to the flame at 3½ inches distance. The loss with the smooth side to the flame was 22 per cent., and with the rough 24 per cent. The same course was adopted with the 27-oz. sheet, and the losses were—for smooth, 30 per cent.; for rough, 34 per cent. With the 24-oz. ground sheet the experiments were carried completely through, and are given in the following table:

Table No. 6 (24 oz. Sheet).

Light by Argand....	17.5	17.5	17.5	17.5	17.5	17.5	17.5	candles.
Distance of screen from flame.....	3½	8	10	12	15	18	20	inches.
Rough side to flame, loss.....	39	48	50	58	60	60	60	per cent.
Smooth side to do., loss	30	44	49	52	57	57	58	"

Another screen of 17-oz. ground sheet gave at 3½ inches distance—loss for smooth side, 30 per cent.; for rough side, 36 per cent.; and at 8 inches the loss for smooth was 44, and for rough 45 per cent. *A priori* such results would not, perhaps, be looked for; but that they must be true, a moment's reflection will show. Plain sheet (Table No. 2) at 3½ inches distance cuts off 11 per cent. of the light. The 16-oz. ground glass in Table No. 3, with the same power of light, cuts off 24 per cent.; and if, as may be fairly done, the obstructive power of the clear parts of the glasses be taken as equal, there remains 13 per cent. as the obstructive power of the ground surface. Hence the 17.5 candle power would be reduced to 17.27 before reaching the clear portion of the ground glass, while with the smooth surface to the flame the power would be 17.31 when the ground surface was reached. This, however, is far from being sufficient to account for the differences actually found, and therefore it must be assumed that reflection, refraction, and dispersion operate, and are really the major causes of the better effects given when the smooth surfaces are presented to the flame.

Before putting the sheet glass aside, a few experiments were made to ascertain the effect of sheet glass as a reflector. The sheets used were of the same size, one was placed 3½ inches in front of, and the other at the same distance behind the flame, which was of 17.5 candle power. Clear glass behind produced 3 per cent. difference, as will be shown in my second article. The loss with 16-oz. ground sheet (Table No. 3) with ground glass behind was reduced from 24 to 22 per cent.; with 27-oz. (Table No. 4) ground sheet, with opal glass behind, the loss was reduced from 34 to 21 per cent.; so that the value of the reflected light was 2 and 13 per cent. respectively.

A sample of sheet glass 0·07 inch thick, lightly flashed on one side with opal, gave the same result with either flashed or plain side to the flame. This fact seems to support the hypothesis already mentioned in relation to the refractive and dispersive powers of ground glass. The flashed opal glass was found to operate in the same way as ground glass with respect to obstruction—viz., that it causes a *diminishing* percentage of loss of light as the power of the flame is increased.

OPAL GLASS.

Table No. 7 (Flashed Opal Glass).

Light by Argand..	13.5	13.5	13.5	13.5	13.5	13.5	13.5	candles
Screen at.....	3½	8	10	12	15	18	20	inches.
Loss of light.....	72	92	96	96	—	—	—	per cent
Light by Argand..	17.5	17.5	17.5	17.5	17.5	17.5	17.5	candles
Screen at.....	3½	8	10	12	15	18	20	inches
Loss of light.....	66	86	88	88	—	—	—	per cent

A sheet of 21-oz. opal glass, such as is used for the tops of lanterns, at 3½ inches from an Argand flame giving the light of 19 sperm candles, obstructed 96 per cent. of the light, and at 8 inches distances more than 99 per cent. An analogous result had been obtained with another sheet of the 21-oz. A sheet of 15-oz. opal at 3½ inches distance from a 19-candle power flame cut off nearly 88 per cent. of the light, and at 8 inches distance 97 per cent. In order to simulate the effects which are produced when a burner is used in a lantern, a screen of clear sheet glass was placed in front of the burner, and the intensity of the light was thereby reduced from 19 to 17 candles. The opal sheet of 21 oz. was next placed at 7 inches behind the flame, when it was found that the reflected rays exactly compensated for the loss caused by the clear glass in front, the power of the horizontal light being as with the unscreened burner—19 candles. The more transparent 15-oz. produced nearly as good an effect—raising the 17 candles power to about 18¼ candles. At 4½ inches distance behind the flame the reflection raised the power from 17 to 20 candles, and at 3½ inches to nearly 22 candles.

SECOND ARTICLE.

At the end of the previous article, particulars were given as to the effects produced by glass sheets as reflectors. Further trials were made, but it is needless to tabulate any save the following:

OBSTRUCTION AND REFLECTION.

Table No. 8.

Screen of thin sheet glass 3½ inches in front of 19 candle Argand flame.....	loss 10 per cent.
Do. with reflector of 16-oz. clear sheet 3½ inches behind the flame.....	loss 7 per cent.
Screen of 16-oz. sheet 3½ inches in front of 19-candle argand flame.....	loss 11 per cent.
Do. with a thin sheet as a reflector 3½ inches behind the flame.....	loss 8 per cent.

Power of the reflected light in each case, 3 per cent.

GLASS CYLINDER,

12½ inches diameter, thickness about equal to 10-oz. sheet.

Table No. 9.

Light from Argand without cylinder.....	13.5	19 candles.
Loss of light with Argand in centre of cylinder.....	3.7	3.8 per ct.

In the last example I have been compelled to indicate the losses to decimal places. Practically the percentage loss of light may be regarded as equal to 13½ and for 19 candles power; the *actual* loss with the low-power flame being equal nearly to one-half candle power, and with the higher power flame to nearly three-quarters of a candle's value. The experiment with the cylinder furnishes the first illustration of the practical superiority of curved surfaces as reflectors of light, the percentage and actual loss with the cylinder being only about half that caused by the flat sheets, although the latter were so much nearer to the flame than the glass of the cylinder. Truly the illustration relates only to horizontal light. To what extent curved surfaces may be better, as regards angular or slant lights from burners above the level of the object which is illuminated, remains in some degree yet to be determined. As far as I can see at present, the only form of lantern or moon which is advantageous in respect to "slant" light is the globe, or some form closely approximating to it.

GLASS GLOBE SERIES.

Table No. 10. (Clear Glass Globe, 7 in. diameter).

Light by Argand without globe.....	13	19 candles.
Loss of light with globe.....	2.7	3.0 per ct.

This is a second illustration of the advantages of curved surfaces, the losses being a little less than with the greatly larger cylinder, while the maximum only amounts to 3-7ths and 3-8ths of those shown with clear sheet in Table No. 8.

The value of the light reflected from curved surfaces of clear glass is manifested by the results given in the two immediately preceding tables; but I felt that it was desirable to go a step farther with clear, ground, and opal globes. I therefore determined to cut some globes into halves in the direction of their vertical axes. This I found a thing easier to conceive than to effect; however, after trials and some breakages I succeeded in getting one clear, one ground, and two opal moons very accurately divided in the manner wished for, and then contrived a simple manner of using these halves in three ways. First, one-half in front of the burner as a screen or obstructor of light; secondly, accurately fitting the second half to the first half, so as to enclose the flame centrally within the two, which together constituted a perfectly formed moon; thirdly, one half behind the flame as a reflector of

light. In every instance great care was taken to adjust the parts of the globes so that the circumferential line of greatest diameter should always be at exactly 3½ inches distance from the centre of the burner, the entire globes being 7 inches in diameter. The results obtained are shown in the following tables :

Table No. 11 (*Clear Glass Globe*).

Light by Argand without globe	14 candles.
Half globe in front of flame, loss	8.7 per cent.
Both globes surrounding the flame, loss	2.2 "
Half globe behind the flame, gain	4.2 "

The results with the section globe, therefore, nearly confirm those obtained with the whole one.

TABLE NO. 12.

Globe of Clear Glass ground outside.

Light by Argand without globe	8	15	20 candles.
Half globe in front of flame, loss	32	28	28 per cent.
Both halves surrounding flame, loss	25	19	17 "
Half globe behind flame, gain	9	10	13 "

An entire Globe ground outside.

Light by Argand without globe	13.5	19 candles.
Loss of light with globe	19	18 per cent.

Sections of Globe with Batswing Burner.

Light from open burner, side of flame to disc=11.6 candles=100
" " edge " " =11.2 " =96.6

Losses calculated on power as=11.6 candles.

Flame to Disc.	Side.	Edge.
Half globe in front, loss	28	26 per cent.
Both halves surrounding, loss	23	23 "
Half globe behind, gain	14	16 "

Two globes, one ground outside and the other inside, gave results which differed in no material extent in obstructive power. These were both finely ground, and the flame was invisible through the glass, but a globe more coarsely ground inside, and through the glass of which the flame was visible obstructed only 14 per cent. of light as against 18 per cent. with each of the others. This evidence would at first sight seem to contradict the results given by ground sheet glass in Table No. 6, where differences in the transmitted or obstructed light are shown with the rough side and the smooth side to the flame; but a little consideration not only disposes of the apparent contradiction, but turns it into a proof of the correctness of the results obtained with ground sheet.

It is stated in the first article, under the heading "Opal Glass," that with a light equal to 19 candles, 21-oz. opal sheet, at 7 inches' distance behind the flame, reflected light equal to a quarter of a candle power in excess of the light reflected by the more translucent 15-oz. opal. Hence it is manifest that with such glass as is in question, the greater its power of obstruction to transmitted rays, the greater its power for reflecting light. This is an ordinary characteristic of reflectors, which will be very clearly evident when we come to a consideration of Table No. 13. The ground surface of glass must, as already demonstrated, be most *obstructive* to the transmission of light; therefore it follows as a corollary that this surface must possess the highest power for *reflecting* light. When a globe is ground *outside*, the reflective power of the ground surface must be less than when ground *inside*, for in the first case before reaching the external ground surface the light must pass through the clear portion of the glass and thereby become weakened, and then before it can produce any beneficial effect in the way of reflection become more weakened on its return journey through the clear portion of the glass; the final effect being a complete neutralization of the theoretical advantages of presenting the clear surface to the flame, which are indicated by the experiments with sheet glass.

Comparing Tables Nos. 3 and 12 as far as can be done—viz., 16-oz. sheet, at 3½ inches' distance in front of the flame, and the half globe in front of the flame—it will be seen that the loss with the half globe is, as might be inferred without experiment, greater than with the the sheet, being 28 per cent. with a 15-candle flame, as against 26 per cent. for the sheet with a 13½ candle flame. It will be further observed that the half globe as an obstructor follows the same law as the ground sheet—viz., *the percentage power of obstruction diminishes as the power of the light is increased.*

With the globe (Table No. 12) as a hemispherical reflector, the *percentage* of light reflected *increases* as the power of the flame grows greater, while the absolute amount of reflected light rendered sensible is less proportionately with high powers than with small ones. Thus the gain with 8 candles' light is 9 per cent., but with 29 candles the gain is only 13 per cent. Had the gain been directly proportionate to the powers of the flames it would have been 9 and 22.5 per cent. respectively, or a difference of 13.5 instead of only 4 per cent. between the extremes.

Continuing the examination of Table No. 11—

The losses with half globe in front are	32	28	28
" both halves are	25	19	17
Differences	7	9	11
The gain with half as reflector is	9	10	13
Reflected light lost	2	1	2

So that 78, 90, and 86 per cent. of the light reflected by the back half of the globe was rendered sensible with the globe as a whole. Doubtless the progression is more regular than indicated, but the observed effects are as near as can be expected with any accepted standard photometer.

There are some other features of interest in this table which may mean much or little in the way of suggestion. Thus, taking the algebraic differences between the losses with the half globe in front by itself and the half globe behind by itself, it will be found that the differences tend to be constant, thus—

	+9	+10	+13
	−32	−28	−28
Differences	−41	−38	−41

Again, if the gain with the back half be subtracted from the losses with the front half, the results tend to be equal to the losses with the entire globe, thus—

Loss	32	28	28
Gain	9	10	13
Difference	23	18	15
Instead of	25	19	13

With the unscreened flat-flame gas-burner, the light was, as is always the case with ordinary flat-flames, *less* with the *edge* to the disc than with the *flat* or *side* to the disc; while with half globe behind the gain by reflected light was, with the *edge* to the disc, greater by two per cent. than with the *side* to the disc—a reversal of the effect which ensues with the unscreened burner. This fact is more fully developed with the more obstructive but more highly-reflecting opal moons, as exemplified by the next table.

TABLE NO. 13.

Opal Globes, 7-in. Diameter.

	French.			German.			
Argand without globe	8	15	17.5	8	15	17.5	candles.
Half globe in front, loss	65	66	65	69	70	69	per ct.
Both halves, loss	50	50	50	52	54	55	"
Half globe behind, gain	48	46	49	60	62	65	"

An entire Opal Globe, 7-in. Diameter.

Argand without globe	13	18	19 candles.
Loss of light with globe	54	56	56 per ct.

Sugg's "Christiana" Albatrine Globe, 7-in. Diameter.

Argand without globe	13.5	17.5 candles.
Loss of light with globe	37	37 per ct.

Sugg's Argand Albatrine Globe, 7-in. Diameter.

Argand without globe	14	18 candles.
Loss of light with globe	33	33 per ct.

Batswing Burner.

Light from open burner, side to disc=11.6 candles=100
" " edge " =11.3 " = 97.4

Losses calculated on power as=11.6 candles.

German Opal Globe, 7-in. Diameter.

Flame to Disc.	Side.	Edge.
Half globe in front, loss	72	71 per cent.
Both halves	69	58 "
Half globe, behind, gain	63	66 "

Both French and German opal globes manifest a tendency to *increase* in obstructive power as the light grows *stronger*—the German globes to the greatest degree; and as this offers the most obstruction to the passage of light, so its half as a reflector gives, consistently, the best result, and its power increases more rapidly than the French glass. Setting the effects out in the same way as was done with the ground globe, we find—

	French, per cent.			German, per cent.		
Losses with half globe in front	65	66	65	69	70	69
" both halves	50	50	50	52	54	55
Differences	15	16	15	17	16	14
Gain with half as reflector	48	46	49	60	62	65
Reflected light lost	33	30	34	43	46	51

The entire opal globe is one of the best out of many which were tested and found to be much alike, and the losses with it agree very nearly with

the means of the results realized with the German and French globes. Mr. Sugg's globes not only show an immense superiority over the common globes in respect to lower obstructive power, but they also manifest a tendency to maintain a uniform percentage resistance, and it is but fair to say that these globes were not selected for experiment, but bought in the ordinary way of trade. Their first cost is high as compared with the ordinary German and French globes, but when a due estimate is made of the greater quantity of light which they transmit, they are really cheaper than the others.

The experiments with the batswing burner bring out prominently a rather startling fact, which was only just indicated with the ground glass globe—viz., that a flat flame enclosed in a glass globe, behind a hemispherical glass screen, or in front of a curved reflector, gives in horizontal line the most light from its edge. The reasons for the more power reflection are not difficult to find. First, the broad side of a flat flame acts itself as a screen to absorb and obstruct the passage of the rays reflected by the part of the globe farthest from an object; and, secondly, the angles at which the rays of light fall on the reflector are more favorable with the edge flame for projection in horizontal lines. Why a similar result should ensue with a screen in front is more difficult to understand, inasmuch as the edge of the flame when without glass gives the least light. As, however, the truth is as stated, one must, for the present at all events, conclude that the closer proximity of one part of the flame when the edge is presented to a transparent or semi-transparent screen, diminishes the power of the resistance of such screen to the passage of light.

I cannot close this section of the subject without drawing attention to the striking differences between some of my results and those of Mr. King and Mr. Wood. Dealing first with ground glass globes Mr. King's loss is 29.48 cent.; Mr. Wood's 40 per cent.; while my maximum, with a flame of 8 candles' power only, is but 25 per cent., and the average loss with all the many globes I have tried, for about 15 candles' power, only about 18 per cent. As I remarked at the beginning of my first article, globes with small openings were almost, if not quite universal in 1860, and I thought it possible that this might be the cause of part, if not the whole, of the discrepancies between my results and those of the above named gentlemen in respect to globes. I therefore, by the insertion of a metal neck, reduced the lower opening of the clear glass globe to 2½ in. diameter, but the difference produced was very trifling, while a somewhat startling fact was discovered—viz., that so far from a clear globe of good glass *diminishing* the amount of light given from a flat flame, the globe positively causes the flame to become more powerful. Thus with a flame giving light—

Without moon.....	=9	9.5	15 candles.
The gain was.....	6½	6	4 per ct.*

As it is impossible for me or any one else who is acquainted with the gentleman in question to imagine that they were in error, I conclude that the globes with which they operated were inferior to those now to be had, and much more obstructive to the passage of light.

Concluding Article.

ELEVATED OR OVERHEAD LIGHT.

In order to carry out the experiments necessary to ascertain the effects which ensue with overhead lights, I was obliged to devise and construct a special photometer—so styling the complete instrument. Instead of the usual bar, two truly planed and blackened planks were employed. These were united at their ends, but separated from each other intermediately by a space forming a slot 1 inch wide. At one end of the compound bar thus formed, a pillar 1¼ inches in diameter and about 4½ feet long was erected vertically and firmly. Attached to a collar which accurately fitted the outside of the pillar was an arm having a regulating cock and an elbow nose-piece at its extreme end to carry the burners; the arm with a pillar forming a right angle. A binding screw in the collar enabled me to fix the arm at any desired height within the length of the pillar. The gas was supplied to the burners through a flexible tube attached to a nose-piece in the arm. The arm being raised to its greatest height and there fixed, a plumb-line was dropped from the centre of the nose-piece, through the slot in the photometer bar, and when oscillation had ceased the cutting point of the line was marked on the bar. From this point a length of 24 inches was laid off on the bar, and at this distance the photometer disc was fixed. The Methven standard was fixed upon a slide, the lower part of which fitted the slot in the bar. The gas was supplied through a second flexible tube attached to a brass tube passing through the slide and terminating on the top with a socket which received the Methven standard. The pipe below the slide and photometer bar formed a handle by which to move the slide, which at the end facing the disc carried a broad black screen of sheet iron, having a central slot for the light from the standard to pass through. A tall black screen having a wide slot in the centre was interposed between the operator and the lights to be tested, so that the eyes were not distressed by direct rays. Next an accurate scale of inches and parts was laid down from the fixed disc toward the end of the bar opposite to that at which the pillar was fixed. Finally black curtains were suspended from the ceiling at each end of the bar, and the ceiling was colored dead black. The pillar and sliding arm enabled me to bring the flames on the same plane as the disc, and also to raise them above that plane. As the operating room was rather low in pitch, I adopted 2 ft. 3 in. above the disc to the centre length of the flames as the elevation to work with; thus the length of the "slant" line, or third side of the triangle, from the centre of the flame length to the centre of the disc, was 36.1248 inches. At this elevation the flames burned perfectly. The whole of the first series of experiments—nearly 40 in number—were completed before any attempt was made, by squaring and dividing the numbers representing the distances, to ascertain their significance, and, as in previous experiments, the powers of the unshielded flames were repeatedly ascertained.

At the outset of the experiments it became strikingly apparent that the generally accepted dictum—viz., that an object at a certain distance from a flame is illuminated to the same degree, irrespective of its position in relation to the flame—is entirely erroneous. The law that light diffuses itself equally in every direction is true only when the source of light is infinitely small, or at so great a distance that the divergence in angle becomes immeasurable; but it is not true with flames such as are universally employed. Although I expected to find differences between the amount of light falling on the photometer disc with flames horizontal and at an angle, I was at first greatly surprised at the enormous differences.

In the first set of experiments with an Argand and with a batswing burner, the results were—

Argand horizontal light	13.32	=	100
" angular "	6.00	=	45
Apparent reduction in light.....			55 per cent.
Batswing horizontal light	10.938	=	100
" angular "	6.062	=	55
Apparent reduction in light.....			45 per cent.

In the second set the results were—

Argand horizontal light.....	13.49	=	100
" angular	6.04	=	45
Apparent reduction in light.....			55 per cent.
Batswing horizontal light	9.784	=	100
" angular "	5.766	=	59
Apparent reduction of light.....			41 per cent.

These two sets of experiments were conducted on different days, and without the slightest effort to make the second set conform with the first during the observations or afterward.

The reasons for the differences or lesser amount of illumination of any special object in an angular position in respect to and below the level of a flame are, it appears to me, as follows:

I will first deal with the Argand. When an Argand, of the type generally used, is in an elevated position, and the light is received from it at a moderately large angle, as was the case in my experiments, when the height was 2 feet 3 inches to the mid length of the flame, and the photometer disc coinciding with a radius of 2 feet, the body of the burner cuts off part of the flame. Moreover, a great part of the luminous flame is above the mid-length, and hence further removed from the disc or object to be lighted. As the angle grows smaller—that is, as the disc or object is moved farther away on the same level—the percentage of obstruction caused by the burner must grow less, although, of course, the actual intensity of power of the incident light will also decrease.

With a flat-flame burner the percentage of reduction is less than with the Argand, and doubtless because the burner itself cuts off none of the rays, except directly downward. The great cause of the effects found, however, remains to be explained, and can be best done in an abstract way.

Let it be supposed that A is a source of light exactly two inches square or four inches in area, and that B is a vertical object placed at a lower level and of exactly the same size and shape as the source of light. Extending lines (1, 2) from base to base and apex to apex respectively of the object and the source of light, and the depth of a channel is defined which must include every possible ray of light which can reach the object from the source. The lines represent the upper and lower part of a tube, the cross section of which is of less area than the source of light or of the receiving object. The width of the tube is the same—viz., 2 inches; its *depth* is less. In the positions I have adopted the depth of the tube would only be

* Doubtless this is due to the better conditions of combustion, the flame becoming much steadier within the globe.

1.375 inches as against the 2-inch lengths of the source and of the object, and the area of such tube is only 2.75 inches as against 4 inches. Dividing 2.75 by 4, the result indicated is 68.75 per cent. of the actual light yielded from the source. The percentage of the light with the batswing in horizontal line—viz., 10.938 and 9.784—equals 7.52 and 6.73, instead of 6.062 and 5.766, the experimental results being about 12.4 and 11.7 per cent. inferior to the calculated ones. But if we regard the cross rays (3, 4), much of this is accounted for; the rays proceeding from the upper part of the batswing, which is the most intensely luminous, have a longer path to travel, while the way is shortened only for those rays which issue from the base, and for the most part non-luminous portion of the flame. I cannot attempt to demonstrate this matter exhaustively, and I feel, moreover, that at present, at all events, it will be sufficient to give the results of my experiments, and indicate possible and probable causes for what might otherwise appear surprising or even incredible.

If my reasoning be correct, it follows that, if the relative power of two opposing flames at the same elevation, but of unequal strength, be estimated by the aid of a photometer placed at a lower elevation, an injustice would be done to the smaller flame; because its "tube" of rays would be reduced to a greater degree in area than that of the more powerful flame. Again, if the two contrasted flames were at different elevations, a similar error might arise.

GLOBES WITH OVERHEAD LIGHTS.

Table No. 14.

Indicated power of Argand flame when overhead	=6 candles.	
Loss with ground glass moon	21.00	per cent.
" albatrine "	23.00	"
" clear glass "	2.77	"
Gain with Germany opal half globe behind	30.00	"
" ground glass " "	6.60	"

Batswing Burner.

Indicated power of flame when overhead	=6 candles.	
Gain with ground glass globe	9.00	per cent.
" German opal "	21.00	"
" albatrine "	23.00	"
" clear glass "	5.50	"

Dealing first with the Argand flame—with the same globe ("entire," Table No. 12), and with a flame equal to the power of 13½ candles, the loss on the horizontal line was 19 per cent., or 2 per cent. less than with the overhead light when taken to be equal to 6 candles—truly the flame was equal to more than 13 candles when horizontally tested; but it appears to me correct in every case to estimate the loss or gain on power of overhead lights in an angular line. The loss with the albatrine Argand globe (Table No. 13) was 33 per cent.; the loss shown in Table No. 14 is only 23 per cent. This, however, is by no means such a contradiction as it may appear to be. As already shown, when the light from an Argand falls in a downward slanting line, part of the flame is obscured by the burner; but the interior of the globe receives rays from every part of the flame; hence the upper part of the back half of the globe must reflect a greater number of rays than are due to the portions of the flame which are visible in the "slant" line. These extra rays, so to call them, would be very sensible with the albatrine globe, which combines translucency with a high reflection power—qualities which are not combined to anything like the same extent in an ordinary ground moon. The percentage loss with the clear globe is the same as with a horizontal light, Table No. 10. The reflection power of the half of the ground moon was (Table No. 12) 9 per cent.; at 2 ft. 3 in. height it is only 6.6 per cent. The power of the half globe, German opal, was 60 per cent.; with the "slant" light it is only 30 per cent. I should state that all the section or divided globes had 4¼-inch openings at the base and 4½-inch openings at the top. The power of an Argand globe to reflect light angularly would doubtless be greater than that of those employed. Turning attention to the batswing burners, it will be remarked that in every instance the wide-opening globes increase the power of the overhead light, the clear glass, of course, least, but by about the same percentage as stated at the end of my second article for horizontal light.

The angle and position elected for the experiments was such that, on placing the eye in the position occupied by the centre of the photometer disc, in the experiments, the whole of the flame was visible except a mere fringe of the top; hence the light impinging on the disc consisted of direct rays, reflected rays, and such other rays as were refracted through the globe. The power of these reflected and refracted rays was, as might be expected, less than with the half globes, ground and opal, with batswings (Tables Nos. 12 and 13), being in each case about 65 per cent. of the power found with horizontal light.

The effects obtained with reflectors are very suggestive, as they indicate the importance of the form of a reflector even applied over an ordinary gas flame. Thus A produced a much more brilliant effect *within* a radius of 2 feet than either of the two others; the second (B) tended to spread the light widely; while C concentrated the largest number of rays upon the disc. The large loss with C when the screen D was used was due to the fact that there was but little space between the reflector and the screen for the reflected rays to escape, and in consequence the major part had to penetrate the screen. The large reflector B and screen induced little loss, for a reason contrary to that just given; but C being less wide, operated in a similar manner to A.

REFLECTORS WITH OVERHEAD LIGHTS.

Table No. 15.

Indicated power of Argand flame when overhead	6 candles.	
Gain with semi-globe reflector, 7½ in. diameter	52 per cent.	
Gain with conical reflector, diameter at base, 10 in.; at top, 3½ in.; depth, 3½ in.	86	"
Gain with conical reflector, diameter at base, 9 in.; at top, 2½ in.; depth, 3 in	92	"
Loss with reflector A and a spherical-shape albatrine screen 5 in. diameter and 1½ in. deep, around the top of the burner	20	"
Loss with reflector B and the screen D	6	"
Loss with reflector C and the screen D	15	"

Screens placed at the base of an Argand gas flame render the light more soft and agreeable, but, *without* the use of a reflector above, cut off a tremendous amount of light; so much, indeed, that although my scale was 34 inches in length from the centre of the disc, it was not long enough to measure the loss, but even at 34 inches the reduction in light would have been more than 60 per cent.

One of the impressions created in my mind by these experiments is that for the general lighting of rooms and offices with Argands, reflectors should be more obtuse—flatter, in fact, than those commonly made, and be not less than 9 or 10 inches in diameter.

The determination of the composition of the various kinds of glass in the market—sheet, globes, etc.,—together with their light-obstructive powers, would be an interesting subject of inquiry, but is one which I cannot venture upon. Sheet glass looked at edgeways differs very much in color. Some samples are a pale green, some bright green, some dark green, and some green tending to black—the latter tinge being due, possibly, to the use of an excess proportion of manganese oxide in the process of manufacture—while none of them, when held between the eye and a flame, differ to any appreciable degree in transparency. There seems scope for improvement in opal glass, which, in the form of moons, reflectors, etc., is the most agreeable to vision. What is wanted is an opaline glass which, while cutting off the glare of a flame, shall be less obstructive to the passage of light than even the best now made.

The broad general conclusions which I deduce from my experiments are as follows, and if some of them appear to be mere truisms, I think that character will cease to be manifest if the reader will, while reading, refer to the various tables of results which I have given, the summary being only a general index to those tables.

HORIZONTAL LIGHTING.

Sheet Glass.

1. That ordinary sheet glass, apart from thickness, varies in its obstructive power to the passage of light. That the percentage loss increases with the distance of the glass from the flame, and increases also as the light grows stronger.
2. That ground sheet glass, apart from thickness, also varies in obstructive power. That the percentage loss increases with the distance of the glass from the flame, and decreases as the light grows stronger. That the percentage loss depends on which side, clear or ground, is presented to the flame.
3. That with flashed opal the losses follow the same law as ground glass for distance from, and for power of light.
4. That with clear glass as an obstructor of light in front of the flame, and clear glass behind the flame as a reflector of light, the reflected light reduces the loss to a degree dependent on the distance of each glass from the flame.

Globes.

5. That a clear glass globe obstructs light from an Argand flame, but increases the sensible light from a flat flame.
6. That globes of ground glass obstruct less light than sheets of ground glass. That the percentage loss diminishes as the light grows stronger; and is, for an average light, from 18 to 20 per cent.
7. That opal globes obstruct an amount of light equal to 33 to 65 per cent.

OVERHEAD LIGHTING.

8. That the amount of light yielded by a flame in an angular direction is much less than it yields in a horizontal direction.
9. That glass globes with elevated or overhead Argand flames reduce the power of the light—clear globes, about 3 per cent.; ground globes, about 21 per cent.; and albatrine globes about 23 per cent.
10. That glass globes with flat-flame burners, at a certain elevation and within a certain radius, increase the power of the light—clear globes, about 6 per cent.; ground globes, about 9 per cent.; albatrine globes, about 23 per cent.; and German opal globes, about 21 per cent.
11. That reflectors greatly increase the power of the light, within a radius dependent on the shape and size of the reflector; the range of the experiments being from 52 to 92 per cent.
12. That screens at the base of an Argand flame cause a reduction in the power of the light, whatever be the size and form of the reflector.

Connellsville Coke for Domestic Use

The Connellsville Crushed Coke Company, a firm recently organized, have erected a large building, the dimensions of which are 75×36 feet, and placed therein an ingenious and complicated piece of machinery for the purpose of preparing crushed coke for domestic use, to compete with the anthracite coal trade.

As yet the invention has not proven a success, they being able to turn out but two cars of the new fuel per day, the full capacity of which should be twelve cars. The company intend experimenting with the machine during the coming summer, with a view of getting it in proper running order. If successful, they claim that coke for household purposes can be manufactured at a small cost, and that it will come into general use, to the exclusion of coal.

We had intended giving a minute description of this new and valuable invention, and our excuse for not doing so is the refusal of the proprietors to explain its modus operandi until they have it in proper working order.—*Keystone Courier.*

Gas Works Explosion.—Part of the Bucyrus Gas Light Company's Works were destroyed by an explosion, which occurred February 13th. The explosion was occasioned by an escape of gas in the purifying room. No one was injured, the workmen having just gone to dinner. The loss amounts to about $1200.

Correspondence

[The Journal is not responsible for the opinions expressed by correspondents.]

Carbonic Oxide.

To the Editor American Gas Light Journal:

Dear Sir:—I send you an account of the accident of asphyxiation and poisoning in France. Will you be good enough to publish it, and ask that any well authenticated case of poisoning by carbonic oxide be written out and sent to me, so that I may collate the whole for publication?

The matter is of great importance, as we are using carbonic oxide for lighting and other industrial purposes, and it is sometimes found in mines.

I have suffered from this poison, owing to the carelessness of a servant in the hotel where I was staying. If the symptoms could be published largely, so as to be recognized, health and possibly life might sometimes be saved.

Yours respectfully,

Thos. Egleston,
49th St. and 4th Ave.

An accident which occurred near St. Etienne, in France, in September, 1880, is of very great interest to those manufacturers who are using the producer gases for obtaining heat, and also to those who are using gas manufactured by the new methods for illuminating their houses.

It appears from this accident that while the carbonic acid asphyxiates and causes death in a very short time, carbonic oxide poisons the lungs and the brain, and produces symptoms which are painful, and may eventually cause death after an illness more or less long and painful.

The symptoms are, after a few moments' breathing of air impregnated with this gas, violent headache, interrupted respiration, trembling of the limbs, loss of speech, epileptic convulsions, and finally fainting, which may be followed by partial restoration several times, and generally complete loss of consciousness.

One of the most interesting phenomena connected with this accident is that, while the effects of the poisoning lasted in one or two cases for several months, the persons affected were neither exposed for a great length of time to the gas, nor was the gas very strong, for it was found that the quantity of carbonic oxide present was just sufficient to make the flame of a candle bluish.

The phenomena cited above are accompanied with a cold sweat, and on recovery from the fainting fits, with a violent headache and nausea, and violent rushing of the blood through the veins.

One of the most astonishing phenomena of the poisoning is the entire loss of speech while still retaining complete consciousness and control over the body, which explains the singular situations in which some of the workmen have been found after explosions of fire-damp, who were found fallen beside their lamps, which were still burning, and in such positions that it was evident that for some moments before loss of consciousness they had lost their speech, and had communicated with each other by gestures, and had then fallen and had died from poisoning, and not from suffocation or from direct injury from the explosion.

In one case a workman in this condition was rendered not only unconscious, but entirely insensible to pain for a long time, as he received while in this state such severe burns as obliged him to remain in the hospital for many months.

When the gas is diluted with a large amount of air, the symptoms generally shown are very great excitement of the whole nervous system, followed by great prostration. Such symptoms as these are not uncommon where a small quantity of gas escapes in a sleeping room, and are usually attributed to malaria. I have been a victim of this myself.

The best cure for poisoning by carbonic oxide seems to be the administration of considerable quantities of ammonia, and afterward of coffee, and the rubbing of the spine with ammonia. The poisoning appears to be first of the lungs and then of the brain.

New York, Feb. 23, 1881.

Electric Light in Denver.

Denver, Col., Feb. 19, 1881.

Mr. Editor: Knowing that like all gas men, and good engineers, you hunger and thirst for reports of public improvements, and that you may be in a position to enlighten others, I wish to report results of a great attempted exhibition of the electric light in this city.

Five lamps, of the Brush pattern, were erected at the Windsor Hotel, three outside and two in the rotunda. These were to be operated by the generator, set up in a large saw mill, which has a 60-horse engine of fine model. This engine was just about 400 feet distant from the five lamps. The exhibition was advertised to take place at sunset of the 17th instant, and after about one hours' effort to start and adjust the great reflectors the lamps lighted up, and the reflectors were manipulated to throw the rays of light over the people who had assembled to see the show—then, out goes the light; and so it went, in and out, up and down. At one time there were four extinguishments inside of 15 minutes, and at no time during the two and a-half hours (that is, from 7½ to 10 o'clock) of the trial did the light continue over 20 minutes without extinguishment. The parties in charge of the experiment reported that the engine was inadequate to supply the power properly.

I may say that the engine worked beautifully, strongly, and smoothly. On the next evening, the 18th, another effort was made to exhibit in better style; but the last was worse than the first, for after making great efforts to obtain a light, it was found that it could not be sustained longer than 10 to 15 minutes, frequently not more than 30 to 40 seconds. To use the language of Mr. Billings, the owner of the steam engine, "They would start her up, and she would run all right for a minute or two, then the fire would run all round that machine, and the lights would all go out; then they would fix her up again and run her another minute or so, when out she would go again: and so it went on till half-past eight, when they said—well, you may shut down."

Notwithstanding the fact that Mr. Billings's description is exactly correct, the Board of Aldermen resolved that electricity was the light of the future, and agreed to contract with the electric light company for lighting the streets on any plan they pleased to adopt, and the press of Denver pronounced the exhibition a grand success.

While I know that the failure to make a respectable display was to be charged to utter ignorance of machinery and electric work on the part of the parties in charge, rather than to inherent defects of the system of lighting, I would like to learn from parties located nearer to the seat of war whether all the reported grand successes of this light resemble this one; and consist principally in the purchase of a few cheap papers, and cheaper aldermen. Neither the length of this epistle to you, nor my own acknowledged modesty will prevent me from saying that a number of 200 and 400 candle Sugg burners each afforded *more* light than any one of the five lamps which are now on the way to Leadville for exhibition purposes.

"Here's to You."

THE AMERICAN GAS-LIGHT JOURNAL AND CHEMICAL REPERTORY

A. M. CALLENDER & CO.,
PROPRIETORS.

Editor—G. WARREN DRESSER.

PUBLISHED ON THE 2ND AND 16TH OF EACH MONTH
At No. 42 Pine Street, New York.

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LIGHT, HEAT, STEAM, WATER-SUPPLY,
VENTILATION, SANITARY IMPROVEMENT,
AND GENERAL SCIENCE.

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PHILADELPHIA—PRATT & Co., Corner 9th and Arch Streets.
England—C. W. HASTINGS, 22 Buckingham St., London, W. C.
Germany—B. WESTERMANN & Co., of New York

WEDNESDAY, MARCH 2, 1881.

Official Report of Examinations of Gas for two Weeks ending Feb. 26, 1881, made at the Photometrical Room of the Department of Public Works.

Corrected Illuminating Power.

1881. Feb.	Time of Day at which Test were made.	New York Gas Light Co.	Manhattan Gas-Light Co.	Mutual Gas Light Co.	Metropolitan Gas-Light Co.	Harlem Gas-Light Co.	Municipal Gas-Light Co.
		†	*	†	‡	*	†
14	Between 9.30 A.M. and 1 P.M.	26.53	20.34	26.94	24.07	19.42	30.65
15		26.20	20.33	27.05	24.02	19.57	30.85
16		25.83	18.81	26.67	24.18	19.16	29.92
17		27.09	18.63	28.00	24.40	19.31	30.20
18		25.50	19.34	28.88	24.60	19 06	30.46
19		28.22	19.10	28.15	24.25	18.74	30.75
	Average	26.73	19 42	27.61	24.25	19.21	30.47
21		27.48	19.02	26.42	23.51	18.54	31.54
—							
23		25.78	20.08	27.84	23.85	18.10	30.39
24		24.11	19.23	27.08	23.92	18.59	28.56
25		26.98	20.38	29.17	23.57	18.76	29.09
26		26.70	19.89	29.67	24.70	19.19	31.72
	Average	26.21	19.72	27.63	23.91	18.63	30.26

* Five foot lava tip with check.
† Bray's slit union, No. 7.
‡ Bray's slit union, No. 6.
E. G. LOVE, Gas Examiner.

New Welding Process.

Krupp has recently taken out a German patent for a new process of welding tubes and tires. He draws the tube on a pair of ordinary rolls, and heats the whole length of the portions which are to be welded in a portable fire-box, into which air is blown, so that the heat is directed against the weld. After the necessary heat is obtained, the rolls are set in motion and the plate which is to be welded is repeatedly drawn through them.—*Van Nostrand's Magazine.*

Appleton (Wis.) Gas Light Company.

On Tuesday last, the transfer of the Appleton Gas Light Company's property was transferred to a new lot of stockholders entirely composed of our own citizens. The following is the list: E. C. Goff, W. H. H. Stowell, H. J. Rogers, S. K. Wambold, C. A. Beveridge, Geo. A. Farwell, B. T. Rogers, W. S. Warner, A. L. Smith, J. P. Buck, O. E. Clark, and N. B. Clark.

At a meeting of the stockholders, held Wednesday morning, the following directors were chosen: E. C. Goff, W. H. H. Stowell, B. T. Rogers, J. P. Buck, and S. K. Wambold.

At the Directors' meeting the following officers were elected:

President, E. C. Goff; Vice-President, W. S. Warner; Secretary, Geo. A. Farwell; Treasurer, S. K. Wambold.

Finance Committee—W. H. H. Stowell, B. T. Rogers, and J. P. Buck.

Committee on Works—A. L. Smith, H. J. Rogers, and C. A. Beveridge.

Superintendent—Geo. A. Farwell.

As will be seen, the works will henceforth be under the control of leading and prominent citizens. We believe they will spare no expense or pains to serve the public in an acceptable manner.—Appleton *Post*, Jan. 6.

Gas in Indianapolis.

The following circular is issued by the Indianapolis Gas Light and Coke Company:

"The Indianapolis Gas Light and Coke Company respectfully inform the public that they lay service pipes of ordinary length and set meters free of charge. Where gas is burned properly, it is cheaper than oil or candles. One gas jet burning five cubic feet per hour, giving a light equal to seventeen candles, only costs one cent per hour, or $2 per 1,000 cubic feet.

"They keep on hand and sell at cost burners which give the best results as to economy and light. A trial of the gas is solicited; if not satisfactory, the meter will be removed free of charge. Any information desired will be cheerfully given at the office of the company, 49 S. Pennsylvania street.

"From the *News*, Jan. 28:

"'Out of 847 fires in Philadelphia last year, 125 were from explosions of coal oil and gasoline lamps.'"

"JAS. SOMERVILLE, Supt."

Personal.

To all whom it may concern:—This is to certify that I was not in the employ of the Westchester Gas Light Company, of Yonkers, N. Y., at the time of the explosion at their works (Feb. 7th), as my services were dispensed with on the 3d inst.

ELMER B. KNIGHT,
Late Engineer of Lowe Apparatus,
Westchester Gas Co., Yonkers, N. Y.

MANAYUNK, Feb. 17, 1881.

Carbonic Oxide.

In a lecture recently delivered by Prof. Ira Remsen, at Boston, that scientist maintained that air may contain 1-20th of its volume of carbonic acid gas without producing evil effects—a conclusion by no means novel, but sustained by such chemists as Berzelius and Pettenkoffer.

He stated that the most delicate tests failed to reveal the presence of carbonic oxide in the atmosphere of rooms heated by furnaces or by cast-iron stoves. According to his opinion, there may be other pernicious gases in the air breathed, but there is no reason whatever why the deleterious effects should be attributed to carbonic oxide.—*Iron Age.*

Gas Stocks.

Quotations by G. W. Close Jr., Broker and Dealer in Gas Stocks.
(with W B Scott & Co.,)
34 PINE STREET, NEW YORK CITY.
MARCH 2, 1881.

☞ All communciations will receive particular attention
☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid.	Asked
Gas Co.'s of N. Y. City.				
Central	$166,000	50	60	65
Harlem	1,800,000	50	63	68
" Bonds	170,000			103
Manhattan	4,000,000	50	190	195x
Metropolitan	2,500,000	100	145	147
" Scrip	1,000,000	..	102	103x
Mutual	5,000,000	100	65	70
" Bonds, go'd.	900,000	1000	100	104
Municipal	1,500,000	100	162	168
" Bonds	750,000		106	110
New York	4,000,000	100	100	105
Northern	270,000	50	—	100
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	110	115
Citizens	1,200,000	20	45	50
" S. F. Bonds.	320,000	1000	100	105
Fulton Municipal	1,500,000	100	55	60
Peoples	1,000,000	10	25	30
" Bonds.	290,000	...	90	95
" Scrip	250,000	...	75	85
Metropolitan	1,000,000	100	50	55
Nassau	1,000,000	25	45	48
" Ctfs.	700,000	1000	95	100
Williamsburgh	1,000,000	50	60	64
" Bonds		...	98	103
Kings Co	135,000	100	55	60
" " Bonds	40,000	—	—	—
Richmond Co., S. I.	300,000	...	70	75
Out of Town Gas Companies.				
Buffalo Mutual, N.Y	750,000	100	72	76
" Bonds	200,000	1000	95	100
Citizens, Newark	918,000	50	85	90
" " Bds.	124,000	—	105	10
Chicago Gas Co., Ills			125	—
Cincinnati G. & C. Co.			178	180
Consolidated, Balt.			71	72
Bonds....			107	—
East Boston, Mass		25	114	120
Hannibal, Mo	100,000	100	95	100
Hartford, Conn	700,000	25	140	144
Halifax N. S	400,000	40	148	150
Hamilton, Ontario	150.000	40	117½	
Jersey City	750,000	20	140	150
Jacksonville, Ill	120,000	50	100	...
Lewistown Maine	400,000	100	—	100
Laclede St Louis Mo.	1,200,000	100	108	110
Montreal, Canada	2,000,000	100	153	154
New Haven, Conn		25	132	—
Oakland, Cal			33	34
Peoples, Jersey City		...	85	90
" " Bds.			-	5
Pittsfield, Mass			120	130
Rochester, N. Y		50	70	80
" Citizens		100	30	35
Rondout & Kingston			75	80
St. Louis Missouri	600 000	50	250	254
San Francisco Gas-Co., S. Fr'isco Cal.			76	77
Toledo, Ohio			95	97
Troy, Citizens	600,000	100	—	—
Washington, D. C	1,500,000	20	185	200
" Scrip	500,000	20	140	150
Woonsocket, R. I.	150,000	100	80	...
Wilmington, Del.		50	174	...
Yonkers		50	—	70

Manhattan declared a dividend of 5%, on Feb. 21, payable on demand. 200 shares of Manhattan, sold at auction, at 189½ and 195½, ex-dividend.

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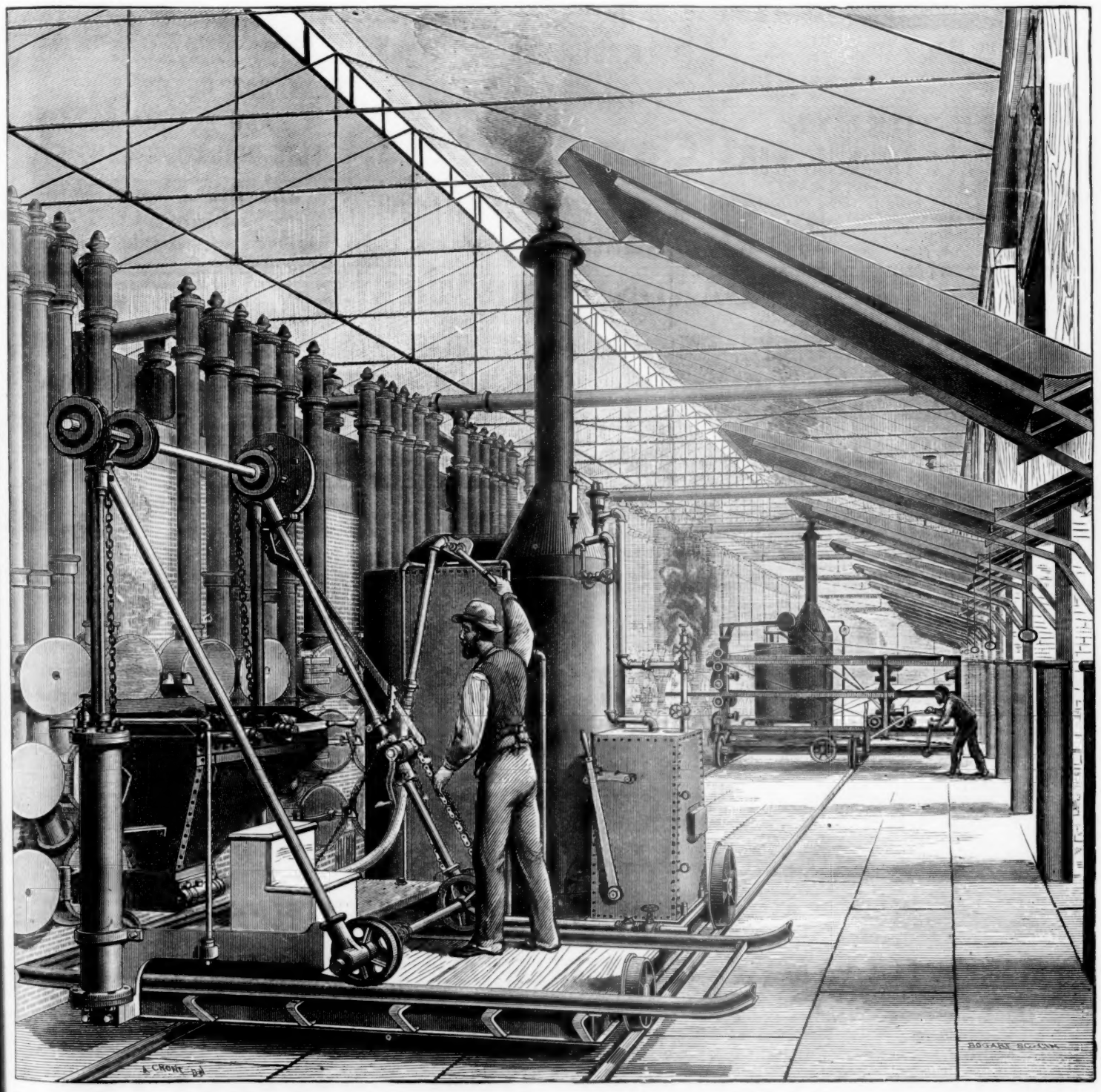

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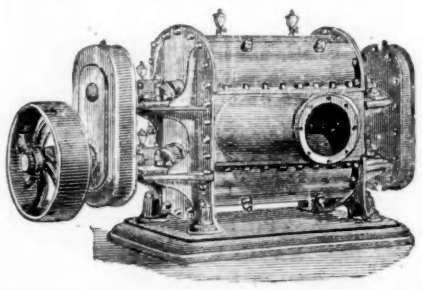

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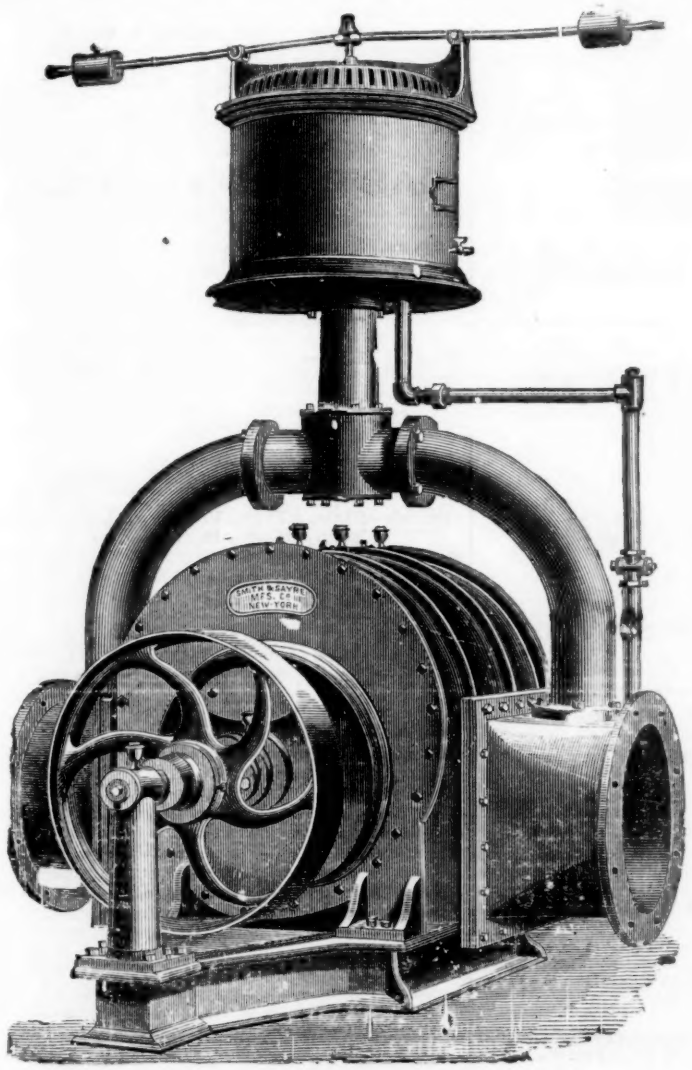

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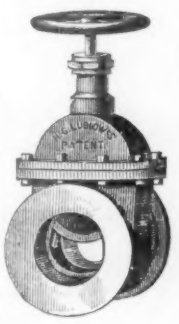

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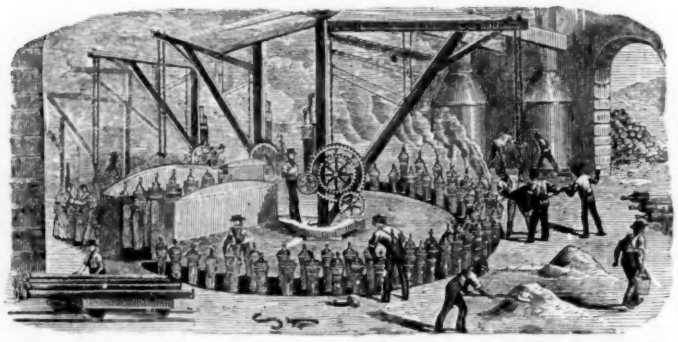

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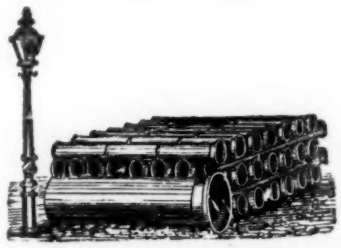

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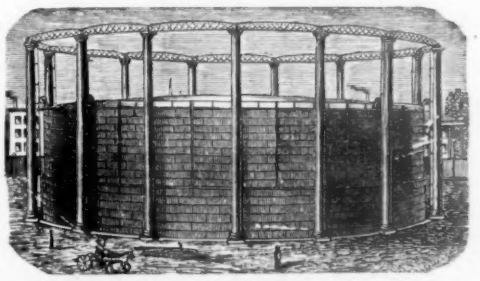

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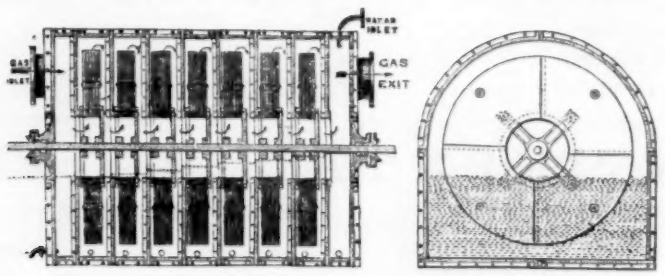

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Attest—J. L. CAMPBELL, Secretary, pro-tem. Signed—A. T. GOSHORN, Director General J. R. HAWLEY, President.

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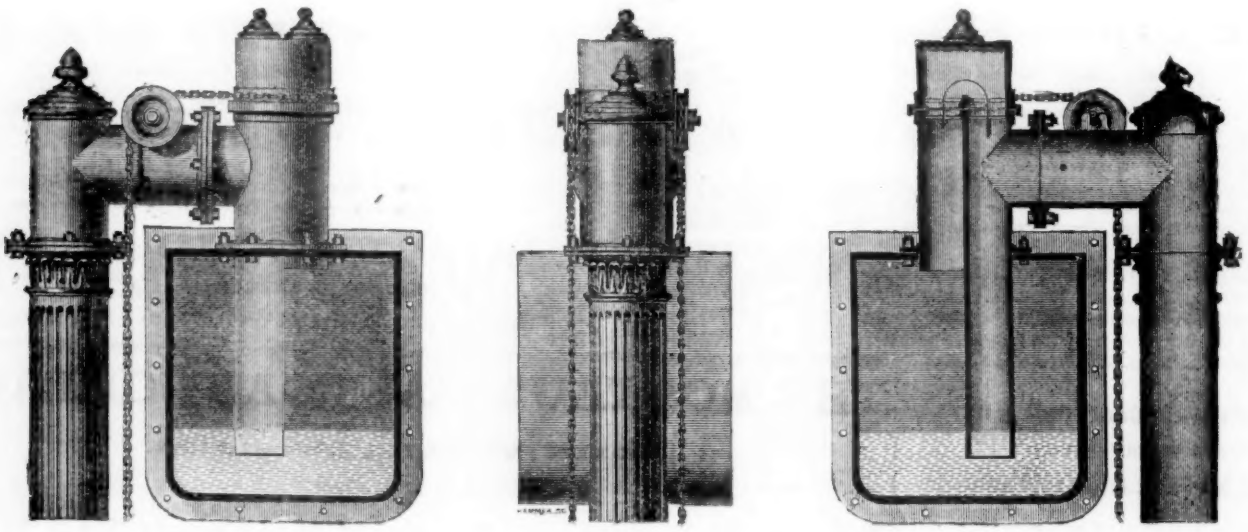

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